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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

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A Memorable Anniversary

THIS week witnesses the semicentennial celebration of Edison's creation of the electric lamp as a practical reality. The commemoration of that event represents a truer appreciation of values than does the celebration of great wars and battles, for during the half-century the life of the world has been transformed, in largest measure because the incandescent lamp carried electric power into the remotest hamlet and into every human activity. As the threads of wire lines spread over the earth and great power houses sprang up, there came about such profound changes that we have hardly yet appraised them. How our existence would be ordered today without the magic growth of disseminated power cannot easily be judged; progress might have been as active, but surely it would have been far different, and our life today would be less rich, in its material equipment at least. The engineer's labors are so closely interwoshed with the growth and use of electric service that to him the present anniversary is peculiarly memorable. If he looks upon the changes of the recent past, he may judge that electricity's transformation of human ways is still only in its beginning. And unless his view extends beyond present attainments he is likely not to perceive in true proportion those relations which will shape his future.

Not Specialization Alone

LAST week's Boston meeting, a distinct high point among recent meetings of the American Society of Civil Engineers, prompts a reflection on the subject of increasing specialization. It is a necessary trend, for the specialist is as essential in this day and age as in prior ages and no doubt those of the future. Such developments as the establishment of technical divisions are therefore of commanding value. Yet if their practical operation is allowed to build up high walls between the closely related branches of our profession, and the men of one branch are discouraged and prevented from keeping in touch with other branches, the wisdom of the arrangement may be questioned. Recent meetings have been ordered in a way that tends to segregate the structural engineers from the sanitary engineers, from the men interested in surveying and mapping or other activities, and vice versa. Last week's meeting at Boston maintained this trend; few members could take part in the discussions of more than one or at best two of the five technical divisions which were in session. It has been well said that the specialist is one who each day knows more and more about less and less, until finally he knows everything about nothing. Civil engineering specialists are of less extreme type; nevertheless there is a danger in developing men who know everything about one specialty but little about civil engineering. It may prove, in the further evolution of the division system, that the truly constructive work of the divisions lies in through-the-year activities rather than in the conduct of meetings. And if so, the general sessions of the society will again assume that broad function of bonding together the whole profession which they formerly exercised, and which, despite the excellence of the Boston program, they are in danger of losing.

Useful Effort

IT IS welcome news that a widely representative group of interested men gathered in a committee by Secretary Lamont of the Commerce Department has begun to study traffic congestion and its remedy. Much work in this field is already going on; all over the country there is concern over the growing seriousness of the problem, and strenuous effort to deal with it. But all these efforts will gain very definitely by the broad correlating effect that the central committee can achieve. Moreover, it is already apparent that the essential steps in traffic relief are such as to depend on wide public understanding and support for their successful application. The committee is in a position to bring about this attitude of mind among business men and citizens of all classes to a degree heretofore not approached, and it can thereby give powerful aid to the labor of local traffic engineers and administrative officials. Its first conclusion, to the effect that better use of existing traffic facilities is more important than the construction of added facilities, indicates that the committee is entering upon its task sanely and with good judgment. Its task is countrywide, affecting city, town and rural community alike. But it is likely to find that the small town and the country community are most in need of its direct help, for they usually cannot provide themselves with the experienced counsel available to cities. The effort begun is a useful one; it merits widest possible co-operation.

Stream Study and Bridge Design

FOR several years North Carolina, in connection with its progressive highway construction program, has been making a systematic study of rainfall, runoff, drainage areas and discharges of all streams crossed by state highways. Data obtained by these surveys have influenced the type and design of highway bridges built by the state. Perhaps this forethought played a part in the events during the flood which swept over the entire Southeast two weeks ago. North Carolina alone of the states involved lost no state highway bridges. South Carolina, a state of similar topography and receiving about the same rainfall, was not so fortunate as its neighbor; several state highway bridges, some of them important, were swept away or badly damaged. Failure of bridges, whether due to inadequate waterway, to unforeseen degree of scour or to massing of flood debris, always represents large losses. For its unfor-

tunate experience the highway authorities are not to be blamed. Handicapped by lack of funds and a sound financial program, the department has been forced to build light structures having minimum waterway clearances without a proper study of stream factors. However, light bridges that have to be replaced after a flood are not economical. The comparison between the flood experiences of the two states serves to show the value of an intensive engineering study of bridge hydraulics, and adequate public support for enduring bridges.

Continuous Bridges

CERTAIN trends in modern bridge engineering were brought into view very effectively by Prof. Charles M. Spofford's paper on the Lake Champlain bridge, read at last week's Boston meeting of the American Society of Civil Engineers. The Champlain bridge is of the continuous type; the reasons, excellently set forth in the paper, include adaptability of form to location requirements, rigidity and erection facilities. Similar reasons exist in many bridge problems, and this is doubtless the explanation of the steady, if slow, advance in the use of the continuous type during the past fifteen years or more. Not long ago a cantilever would have been preferred for the Champlain location, but in the present instance it was rejected at an early stage of the planning. Continuous construction was recognized as giving more regular deflections and being less susceptible to disturbing vibration. None of the old-time fears of derangement of structural action by settlements were entertained, in spite of the great foundation depth, about 100 ft. to rock. As has been pointed out before in these columns, old prejudices against statically indeterminate steel structures are being dissipated in the face of new methods of mechanical analysis, greater structural experience and the more widespread use of constrained structures of reinforced concrete. Along with this development of a new state of mind in bridge designing the continuous steel truss is destined to forge ahead rapidly.

Substitute Ties

AMERICAN railways never have been a good market for substitute ties. In early years timber was plentiful and satisfactory, though short lived, and in the later years tie plates and heavier rails have improved the service qualities of the lower-grade timber to a highly satisfactory degree, while preservatives have extended its life. Under these circumstances no substitute was able to show sufficient all-around superiority to encourage its use. In Europe, where timber costs are higher, the situation is enough different to have stimulated the use of substitute ties more actively. This is especially true of steel ties. In 1922 nearly 40 per cent of the German state railways were laid with steel ties. Yet despite this more extensive use the situation in Europe as regards the development of an entirely satisfactory substitute tie is not greatly different from that in the United States. The latter was effectively summarized in our issue of Feb. 28, 1929, p. 345, and the conclusions drawn in that article might be applied quite directly to Europe. The steel ties used so extensively on the German roads are giving much trouble from corrosion and noisy tracks, and in some instances are being replaced by ties of treated wood. Though perhaps changed economic conditions may be a factor, the general truth is that no substitute tie has been developed which is as satisfactory as treated timber. Wood must become much scarcer than now before other materials will replace it in railway tie service.

Living Structures

"OF ALL the wonderful things which we have seen in this country," said Luigi Luiggi, the well-known Italian engineer, in a recent address, "your skyscrapers have made the most impression upon us. We have seen the pyramids of Egypt, the Parthenon, St. Peter's Church and the Eiffel Tower, but they are, as it were, dead structures, while your skyscrapers are living structures. Not unlike the human body, they have a frame of steel and a skin of brick and stone, a multitude of pipes like veins and the telephone lines for nerves. They are filled with life and activity." This conception of the function of our great buildings which Senator Luiggi expresses is thought-provoking. It finely idealizes our towering office buildings, but it also emphasizes the fact that like all living things they are ephemeral, and are not monuments built for eternity. Today they raise themselves high above our streets to serve a present need, but as the years pass they will become less and less suited to the needs of their day until a time is reached in which they cease adequately to meet the requirements put upon them. For some structures that time may come quickly, as in the case of the Pictorial Review Building in New York; for others it may well outreach the span of human life. But in either case the fact may not be overlooked that these buildings are not lifeless monuments, unaffected by time and change, but are living structures which like all living things will survive only so long as they can be adapted to their environment. Upon the vision of those who build our great buildings will depend, in large part, the span of life of the structures which they raise.

Noteworthy Tunneling

NUMEROUS factors combine to make the new Detroit-Canada tunnel of unusual interest. Economically it is important because it provides a vehicular connection between downtown Detroit and the suburban communities in Canada, although the new suspension bridge now under construction serves the same environs some distance out from the business center of the city. Separate interest, however, centers on the technical aspects of the tunnel project.

Three major types of tunnel construction—cut-and-cover, shield-driven and sunk-in-place—are involved in the project. The shield-driven sections, from the ventilation shafts to the river's edge in both the United States and Canada, are the largest shield tunneling yet undertaken, their diameter being nearly 32 ft. Furthermore, they are lined with structural steel, a noteworthy innovation in view of the almost universal use of cast-iron. Lower cost and light weight determined this choice.

Sunk-in-place tunnels are rare enough to rank as major undertakings wherever or however they are built. The Detroit vehicular tunnel profited by the experiences accumulated in the construction of its principal predecessors in trench tunnel work—at Detroit, at Paris, at the Harlem River crossing in New York City, and at Oakland, Calif. Fabrication of the steel plate shell of the new tunnel was expedited by the use of arc welding. Improvements in the connection details between segments by virtue of simplification over former methods are recorded. The sinking methods used also represent

a departure from most previous practices, the segments being sunk by utilizing the tremied concrete incasement as ballast rather than by flooding the segments.

A further innovation on the new tunnel is the elimination of the elaborate foundations used on some of the other sunk-in-place crossings. Only a sand cushion is considered necessary, by virtue of the comparatively flexible connections between segments. Thus does the engineer apply his ingenuity and newly acquired knowledge to an old problem with consequent simplification and savings. The Detroit tunnel represents advance in tunneling methods well worth study.

Shoulders for Surfaced Roads

GRASSED road shoulders proved highly resistant to erosion from pavement runoff during the recent torrential rains in North Carolina. So pronounced was the protective value of grassing that it was made the outstanding observation of State Highway Engineer John D. Waldrop in his account last week of highway damages from floods following the heavy rainfall. This fact focuses attention on the general subject of shoulder construction, a subject which calls emphatically for new thinking on the part of highway engineers.

At present, road shoulders receive far too little consideration. Indeed, if a conclusion may be drawn from recent treatises and textbooks, they have no place among highway engineering problems. Their neglect results partly from the fact that the functions of the shoulder have changed with changes in road types and traffic demands. In the days of macadam construction the shoulder had the important function of acting as abutment to restrain the stone surfacing from lateral spread; it still serves this purpose in gravel roads, particularly those of trench-type construction. But with the coming of rigid pavements the shoulder lost its purpose as an abutment. It became instead a safety zone between pavement and ditch, onto which the driver could turn without accident if forced off the hard surface. Multiplication of traffic has greatly magnified this function and added others, so that today the widened and leveled shoulder is truly a part of the roadway. It has the important functions of removing halted vehicles from the paved traffic lanes, serving as emergency running surface, and protecting the subgrade structure of the pavement from attrition and displacement.

In the course of this cycle of change there was a period when shoulder structure and construction received only perfunctory attention. Shoulders were constructed of the nearest material from grading or ditch excavation, and if they rutted from travel or scoured from rain wash the damage received little notice and often went unrepaired for weeks or months. In short, the shoulder was little more than an irritation which occasionally disturbed the highway director when his maintenance engineer presented upkeep cost figures or when a claim for a broken wheel was presented. It is this apathy that now needs to be overcome.

The modern highway is roadway from ditch line to ditch line. Any conception of the roadway as a limited part of the total highway width is incompatible with the service which present-day traffic requires and rightly expects; indeed, in many places the full roadside servicing of traffic demands all of the width between fence lines. It is true that different zones of the width serve different purposes, but all of them are the demands of travel. It is this conception that governs modern shoulder design and construction. The same economic and engineering principles apply to the shoulder as to the paving and surfacing of the main travel zone. Questions of strength, durability, safety, cheapness of upkeep, resistance to climate and weather, and traffic economies enter as logically as in pavement design.

According to the varying influence of these several considerations, shoulder structure may range all the way from compacted roadside dirt to an extension of the pavement. The dirt shoulder is likely to be the preferred solution for low and moderate traffic; yet proper maintenance must be provided for no matter how low the traffic density. The highway engineer therefore may not consider an earth shoulder once built and then neglected to be a serviceable and economical element of his road. His problem is solved only when secure maintenance of the shoulder is assured. Hence the timely value of the North Carolina experience with grassed shoulders. If so simple a means can save miles of shoulder from extensive reconstruction after a torrential rain, neglect to use it has small excuse.

In every respect there is need of new study of shoulder construction by highway engineers. It is to be hoped that it may be considered and appropriate action planned at the coming conventions of highway officials and roadbuilders.

A Neglected Tool

HOW many engineers look upon the English language as one of the tools of their profession? Probably few consciously do so. And yet it is one of the most important implements with which every engineer must work, and the young engineer who soonest learns its importance and seeks to perfect himself in its use the quickest clears away a major obstacle which might otherwise keep him from reaching the higher rungs of the professional ladder.

There is more to the engineer's work than making investigations and preparing plans; he must also convince others that the results of his investigations are sound and his plans feasible. Here is where language becomes an important tool. The engineer who masters the art of making a good report, couched, it may be, in technical language, yet making the points sought to be brought out follow one another in logical order, makes the most effective use of this tool.

It is not enough that the engineer convince himself of the soundness of his reasoning; others must be convinced. They may be his employers, a board of directors, a municipal council or, as in the case of regional planning, a whole municipality or a group of municipal units. Therefore, besides learning how to write a good technical report, he should also become adept at composing a short synopsis of that report. This should contain, in language that can be understood by anyone, the salient points he makes in his report and a brief argument for them.

The preparation of such a report entails hard work; much practice is necessary; no one yet has evolved a piece of good writing at the first effort; it has to be written, analyzed, criticised and then rewritten, perhaps rewritten again and again. The author should not be satisfied until he is certain that his effort is the best of which he is capable. The effort entailed is not, as so many engineers appear to think, a perfunctory evil, for upon it may depend the whole matter of an engineer's success or failure.

The Detroit-Canada Vehicular Tunnel

A New Detroit River Crossing of Sunk-in-Place Segments

Fig. 1—Incasing a Tunnel Segment

THE TUNNEL now under construction between the business districts of Detroit, Mich., and Windsor, Ontario, Canada, is the third great subaqueous vehicular roadway to be built in America. Like its predecessors, the Holland tunnel under the Hudson River in New York City, and the George A. Posey tube under the estuary between Oakland and Alameda, Calif., the Detroit-Canada tunnel sets new precedents in subaqueous tunnel design and gives expression to another of the several theories that have been proposed in this field of construction. A departure also is recorded in its shield-driven portions where stamped structural-steel liner plates fabricated by arc welding replace the conventional cast-iron segments heretofore used. The river sections are sunk in a dredged trench similar to that used in the Oakland estuary, but whereas the reinforced-concrete sections of this tunnel were cast in dry dock, the Detroit-Windsor tunnel sections are of structural steel, lined and incased with concrete after being floated.

The Detroit-Canada tunnel extends from a terminal in the business district of Detroit about 1,200 ft. back from the United States harbor line under the Detroit River to a Canadian terminal in the center of Windsor's business district, some 1,800 ft. inland from the Canadian harbor line. From portal to portal the tunnel is 5,135 ft. long, and its length from street grade to street grade is 5,845 ft. In general a 22-ft. roadway is used with 13½-ft. headroom, although two 14-ft. roadways are provided in the approach tunnel section on the American end. The estimated capacity for passenger cars and trucks is 1,000 cars per hour in either direction. Although designed for two lanes of traffic, the roadway is wide enough to pass a third line in an emergency.

A grade of 3.97 per cent leads from the Windsor terminal to the subaqueous portion of the tunnel, and at Detroit this grade is 5 per cent. The government requirement of 30-ft. clearance at the harbor lines was a major factor in determining the grades. Also, the ship channel of the river is relatively near the Canadian shore, which made it necessary to place this portion of the tunnel 45 ft. below the river surface. The 5 per cent grade on the American end resulted from the location of the terminal at a point close to the river, a requirement made necessary by the relatively high land values in the downtown portion of Detroit.

The American terminal, as will be noted from Fig. 2,

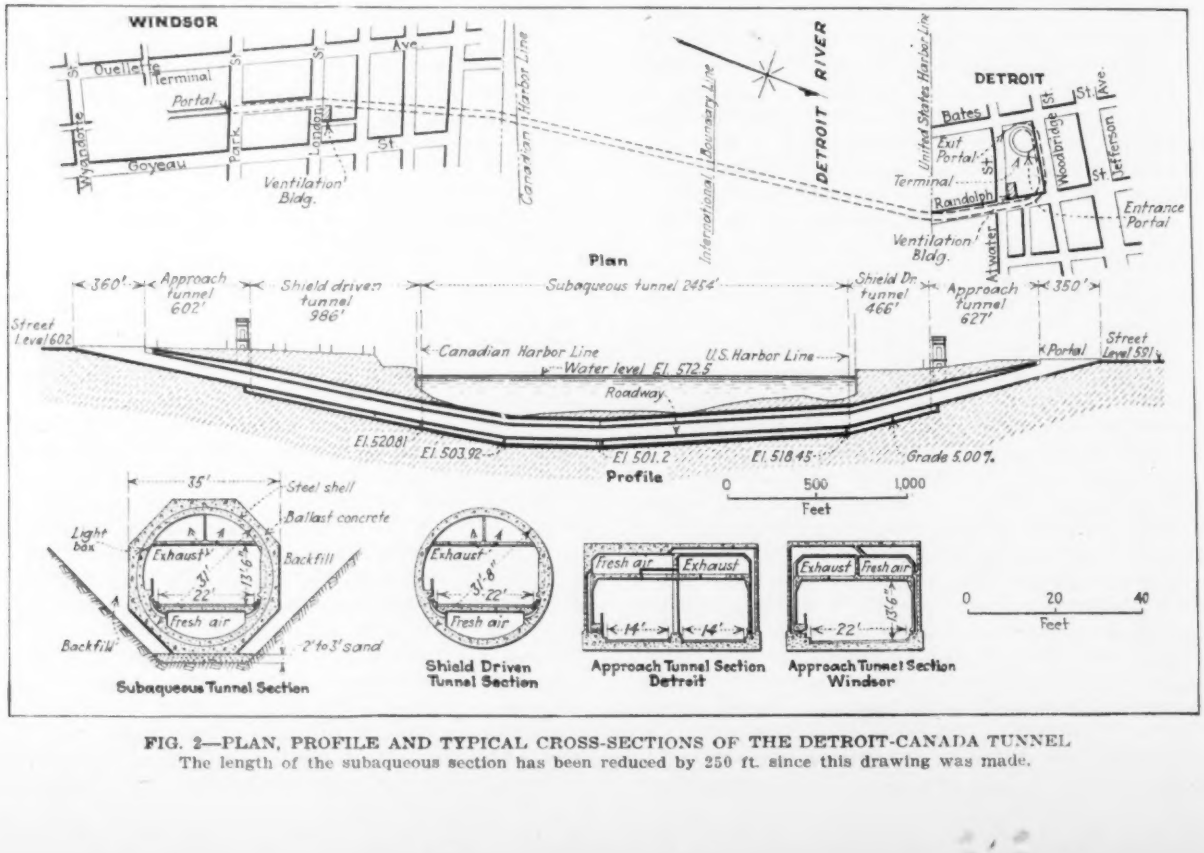


FIG. 2—PLAN, PROFILE AND TYPICAL CROSS-SECTIONS OF THE DETROIT-CANADA TUNNEL
The length of the subaqueous section has been reduced by 250 ft. since this drawing was made.

is on a small tract of land compared with that occupied by the Canadian terminal, the former being selected because of economy in real estate values and early availability of the site. The small area made the layout of the approach tunnel somewhat complicated, inasmuch as it was desired both to separate the entrance and exit roadway lanes and not to exceed a 5 per cent grade. The former requirement was effected by placing the entrance on a spiral curve as shown in Fig. 2.

Real estate values in Windsor were more reasonable and the larger terminal plaza was secured from a school which owned four square blocks and was in a position to sell and build elsewhere. No structures other than the old school building occupied the site, which simplified construction considerably. The terminal buildings on both sides will provide, in addition to offices for the business staff of the tunnel, the necessary facilities for immigration and customs operations.

As shown in Fig. 2, the tunnel is divided, largely for design and construction convenience, into seven sections representing four different designs. At either end of the tunnel there is an open cut incline leading from street grade to the portals. From the portals to the ventilation buildings the approach tunnel sections are of the conventional box-type cross-section with steel bents joined by concrete jack arches and constructed by the cut-and-cover method. From the ventilation buildings to the harbor

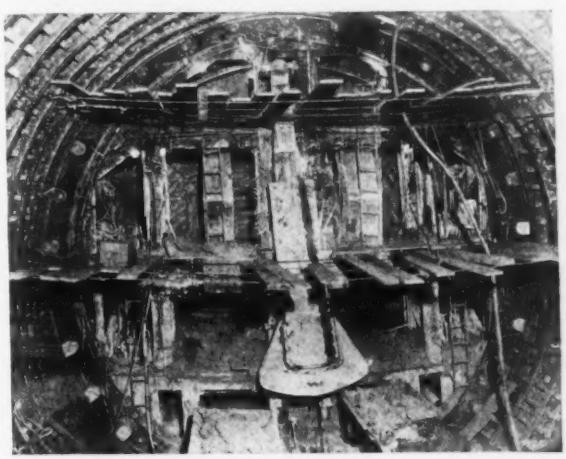


FIG. 3—SHIELD AND STRUCTURAL STEEL LINING IN LAND PORTION OF DETROIT-CANADA TUNNEL

Note the character of material being excavated—a stiff, gray clay. Jacks to move the shield ahead are spaced around the periphery. The heavy member in the center is the jumbo for erecting the lining. This lining is of welded structural steel, a departure from the usual cast-iron construction.

line the tunnel is being driven by a shield, the largest yet used, while in the subaqueous section the tunnel is made up of preformed segments of structural steel lined and incased with concrete and sunk in a prepared trench on the river bottom.

Ventilation—Ventilation design is based upon the data gathered during the preliminary investigations on the Holland vehicular tunnel and later substantiated by experience on that tunnel and on the George A. Posey tube in California. In the Detroit-Canada tunnel the shield-driven and subaqueous portions are similar to the previous ventilated tunnels, having a circular cross-section with the fresh air passageway beneath the roadway and the exhaust chamber above the ceiling. In the box approach section, however, both fresh and vitiated air are carried in passageways above the roadway, although the fresh air is led from this passageway down the side walls and released to the tunnel near the roadway level as with the other arrangement.

There is a ventilation building on each side of the river, each building containing twelve fans, six of which are blower fans and six exhaust fans. The entire equipment will be controlled from a central operating room. Approximately 1,000,000 cu.ft. of air will be required per minute under maximum operating conditions and a complete change of air will be made each 1½ minutes. The power supply layout is so arranged that any piece of equipment may be operated from either the American or the Canadian side.

Shield-Driven Tunnel Design—The 32-ft. shield-driven tunnel section, in addition to exceeding in diameter any other yet attempted, departs from former design in an important particular. This is in respect to the lining, which is of structural steel instead of the previously

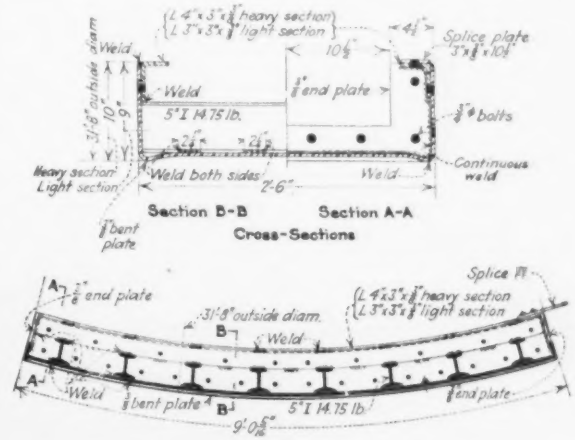


FIG. 4—DETAILS OF STRUCTURAL STEEL LINING SEGMENTS

Segment built up of plates, I-beams and angles completely welded weighs much less than similar cast-iron segments.

used cast-iron segments. Although steel liner plates have been used in England and Germany, the Detroit-Canada tunnel represents the first instance of their use in this country. According to the engineer, this type of lining was adopted over cast-iron segments on the basis both of economy and of strength. The weight of the steel lining is about 2.3 tons per linear foot of tunnel, whereas a comparable cast-iron lining would weigh about 8 tons. It is said that the comparative costs of the steel and cast-iron linings are in about the same proportion as their weights.

As shown by Fig. 4, the liner plates are in the shape of pans 2½ ft. wide, 9 ft. long and either 9 or 10 in. deep, made of ⅜-in. pressed steel. The ends of these pans are closed with a ⅜-in. plate. The top corners are stiffened by means of structural angles, and stiffeners of 5-in. 14.75-lb. I-beams are welded on 13-in. centers across the narrow dimension of the pan to take the thrust of the shield jacks. The liners are completely fabricated by arc welding. In erecting the liner segments 3x$\frac{3}{16}$x10½-in. splice plates are bolted to the outstanding leg of the flange stiffener angles. Each segment weighs about 1,000 lb. and eleven segments and a key comprise a complete ring of lining. In the ordinary ring about 475 bolts are required for assembly.

Subaqueous Tunnel Design—The subaqueous portion of the tunnel is divided into nine sections, the first one, on the American side, being 220 ft. long, followed by eight sections of 248 ft. extending across to the Canadian

side of the river. The first segment is curved near the end to a 1,200-ft. radius as is indicated in Fig. 2.

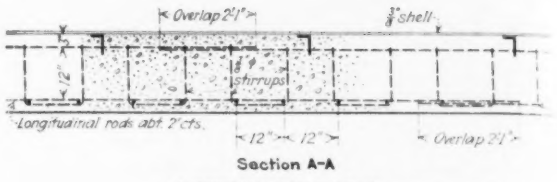
Each section consists of a shell of $\frac{3}{8}$-in. steel plates, alternately 99 and 53 in. wide, placed in and out, with the longitudinal seams welded and the circumferential seams riveted and welded, the latter welding being added to insure watertightness. The steel shell has a diameter of 31 ft., and with the length of plates used, four longitudinal seams occur in the circumference.

For stiffening purposes and to provide a point of attachment for the wooden forms for exterior tremie concrete, octagonal-shaped diaphragms of $\frac{5}{16}$-in. plates are placed along the shell at 12-ft. intervals. The diaphragms are fastened to the shell by a riveted angle and are stiffened on the outer edge by a pair of angles. Further rigidity during construction is insured by the use of spiders placed opposite each diaphragm inside the shell. The diaphragms with the form walers in place are shown in Fig. 5. Fig. 6 is a typical cross-section of the subaqueous tunnel.

These steel segments are lined with 18 in. of reinforced concrete and incased after being launched with tremie concrete, the primary purpose of the incasement being to supply ballast. The steelwork inside the shell consists of circumferential angles placed on 4-ft. centers longitudinally, the outstanding legs of which are punched on 12-in. centers with holes through which the outer row of reinforced steel is threaded. The complete reinforcing is in the form of a cage made up of these longitudinal rods close to the shell, $\frac{3}{8}$-in. stirrups 12 in. wide and 12 in. deep hooked over these rods, another system of longitudinal steel made up of $\frac{5}{8}$-in. rods placed 24 in. on centers outside of the stirrups, and on top of this a system of circumferential rods placed on 12-in. centers.

An unusually simple and effective detail has been devised to join the several subaqueous sections together. Cast-steel lugs are riveted to the sections as shown in Fig. 7. On one end of the section the lug is placed immediately below the horizontal diameter on a lip plate that extends about 18 in. beyond the upper half of the section. On the other end the lug is placed above the horizontal diameter on a similar protruding lip plate. The first section to be sunk had the lug on its outer end below the horizontal diameter so that the adjoining section could be lowered upon it easily. The lugs are connected by a 5-in. diameter pin held in place by a wedge driven below the lower lug. The lower lug contains a slotted hole; the upper one contains two round holes one above the other. Thus by means of the latter the pin is held in a vertical position and at the same time considerable lateral movement is afforded the sections by the slot in the lower lug.

The joints will of course be sealed on the inside by the concrete lining, but provision has also been made for attaching forms to the diaphragms and pouring tremie concrete around the joints on the outside. A detail of these form connections is illustrated in Fig. 7. The channel iron slot is fitted to the form walers and to the



Section A-A

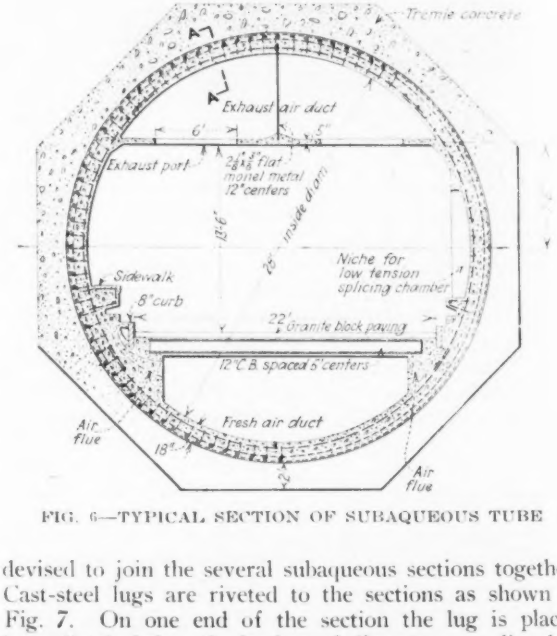


FIG. 6—TYPICAL SECTION OF SUBAQUEOUS TUBE

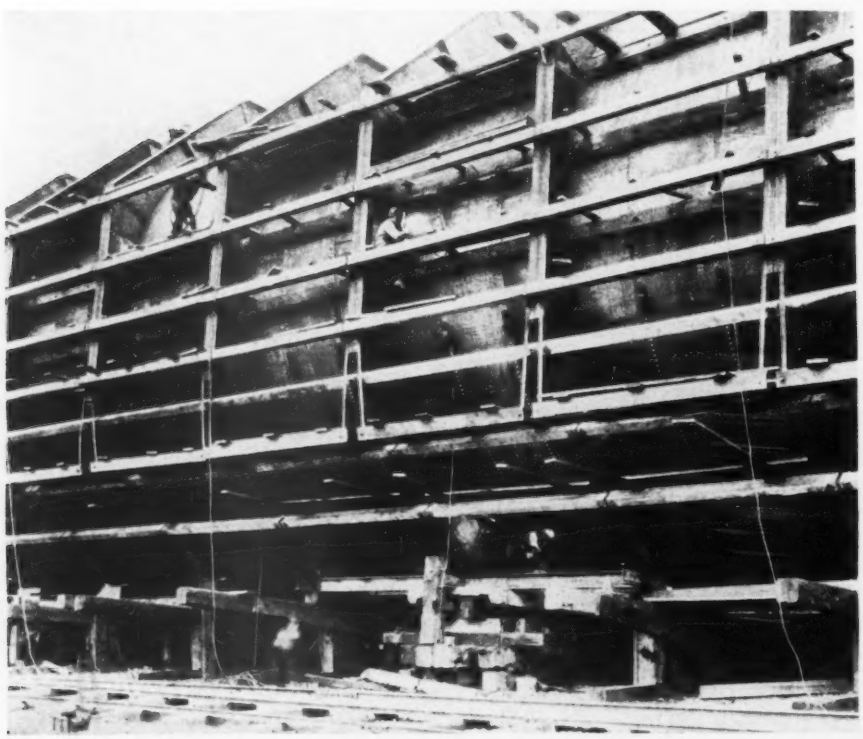


FIG. 5—FABRICATING THE STEEL SHELL ON LAND

Walers attached to diaphragms serve temporarily as scaffolding for the riveters and welders, and finally as supports for the forms for the incasement concrete. Longitudinal seams are welded and girth seams are riveted followed by welding to insure watertightness.

diaphragm at the time the section is fabricated, and into these slots steel forms can be dropped after the sections have been connected together on the river bottom. With these forms in place, concrete will be poured by tremie, inclosing the joint with a collar of concrete which afterward will be grouted through grout holes from the inside.

The joint between the shield-driven sections and the first subaqueous section was made by providing an enlarged bell about 4 ft. long on the landward end of the latter into which the shield was driven. The skin plate of the shield was left permanently in place. In order to effect such a closure the first subaqueous section had to be sunk and the cover of clay replaced in order to eliminate any possibility of blowout when the shield arrived.

In designing the subaqueous segments, 47 ft. of water and 12 ft. of clay fill were assumed to act on top of the tunnel. The tremie concrete was not considered in the stress analysis except for weight, but the combination of the interior concrete lining, the steel shell and reinforcing rods was assumed to act as a reinforced-concrete ring. An average steel stress of 16,000 lb. per sq.in. was used and the concrete was designed for an average stress of 400 lb. per sq.in., with a maximum allowance of 650 lb. per sq.in. The design provided that the segments should float by their own buoyancy and that all ballast should be supplied by the permanent concrete, no sand or other temporary weighting being necessary.

Shield Tunnel Construction—The approach tunnel sections on either side were built by conventional cut-and-cover methods and involved nothing unusual. There is 466 ft. of shield-driven tunnel on the American side and 1,136 ft. of shield-driven tunnel on the Canadian side.

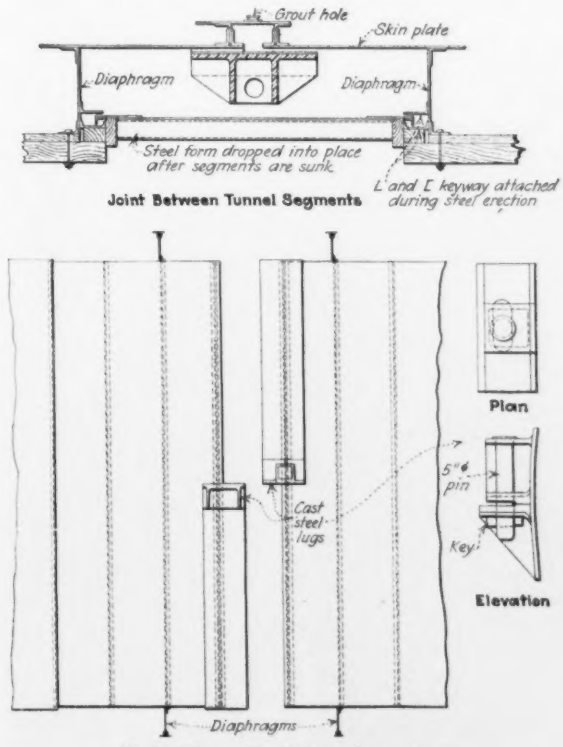


FIG. 7—DETAILS AT JOINTS BETWEEN SUBAQUEOUS SEGMENTS

Castings at horizontal diameter connected by a 5-in. pin placed by divers. Concrete incasement beneath bottom of joint made possible by sliding forms into place after segments are joined at the bottom of river, and pouring the concreting from the inside.

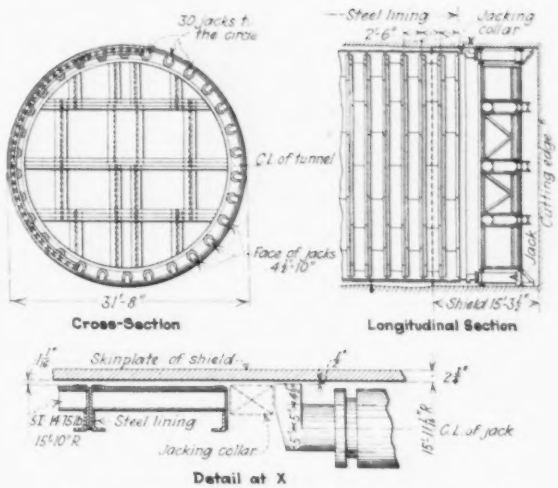


FIG. 8—DETAILS OF SHIELD AND JACKING ARRANGEMENT

This is the largest shield-driven tunnel yet built. Note how jacking collar distributes the reactions from the jacks to the 5-in. I-beam stiffeners in the lining segments.

The shield being used is 32 ft. 3½ in. in diameter and 15 ft. 3½ in. long. This shield-driven tunnel is the largest yet built, the greatest diameter in the Holland vehicular tunnel being 30 ft. 4 in. Details of the shield and a diagram of the method of using it are shown in Fig. 8. Thirty 250-ton jacks are evenly spaced around the circumference and supplied with pressure from pumps and an accumulator in the compressor house. The jacks exert a working pressure of 4,000 lb. per sq.in. on the plungers. To date it has been necessary to use only about 100 tons of the 250-ton capacity of the jacks.

Transition from the cut-and-cover construction to the shield-driven tunnel was made when the steel sheetpiling required for the former reached 53-ft. lengths. This was considered the maximum depth to which open-cut work could be carried economically and at this point a shaft was sunk in which the shield was assembled.

The shield has four working platforms. Because of the stiff character of the clay, all excavation must be removed from in front of the shield by means of clay knives. None of the material, it is believed, will flow into the shield as it is moved forward. Only one shield is being used. Following completion of the American portion it was dismantled and working parts and steel trusses moved to the Canadian side.

One of the noteworthy features is the use of a single structural-steel bulkhead for the shield-driven portions. Only one bulkhead has been provided, and it will not be moved forward from its initial position. The bulkhead is completely bolted in order that it might be easily dismantled after the American section is completed and be removed to Canada along with the shield. This bulkhead, situated about 100 ft. ahead of the construction shaft, is believed to represent the first use of structural steel for this service. One man lock and two material locks are provided.

It is expected that only about 18 lb. of air will be required on the work, and this only to hold back the clay, which has a tendency to settle slightly. Slight difficulties have been experienced from settling buildings, but the settlement is small and uniform. The greater part of the settlement occurs in the annular space between the skin plate of the shield and the excavated portion, and it results from the fact that the clay is unsupported for a

distance equal to two or three rings of lining at this point. Very little water has been encountered, although sand pockets are found at frequent intervals.

When the shield was driven into the end of the first subaqueous section, the skin plate of the shield was left in place permanently, while the remainder of the shield was dismantled and taken to the Canadian side. By the adoption of this method of joining the two types of construction, a very expensive river shaft has been eliminated.

Construction of Subaqueous Tunnel—In building the subaqueous sections of the tunnel, the construction work is divided into (1) fabrication of the steel shell, (2) pouring of the interior concrete lining and the exterior tremie concrete for the keel and (3) the final complete incasement and sinking of the sections, including the dredging and preparation of the trench. Each of the three operations is carried out at a different location.

All of the structural steel fabrication, including the placing of the reinforcing steel for the inner lining, is done on a set of ways at a steel plant some 5 miles down the river from the tunnel location. The ways accommodate two sections at a time, as shown in Fig. 9. Erection is accomplished by crawler cranes assisted by a locomotive crane running on a track parallel to the section. As fast as each ring is assembled, spiders are inserted to round it up, the longitudinal joints are welded and the diaphragms are riveted on the outside. With the diaphragms in place 6x8-in. and 6x6-in. walers are attached to them on approximately 4-ft. centers, these walers serving the dual purpose of providing scaffolding for the riveters and welders during fabrication and later for carrying the exterior concrete forms. As rapidly as circumferential joints are riveted, the welders, using electric welding sets, run a bead around the seam as added insurance against leakage. Small lugs are also riveted into the shell steel, these lugs forming attachment for the hook bolts which hold the form lumber against the walers. Upon completion of the steel shell, and before

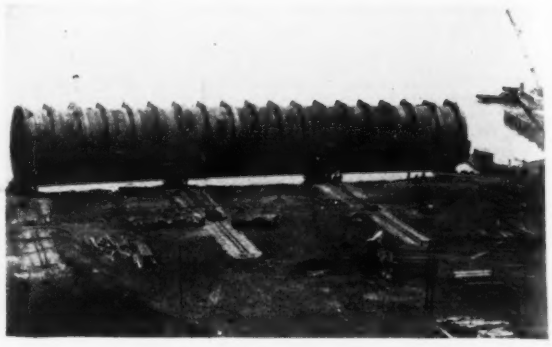


FIG. 10—FIRST SEGMENT BEING LAUNCHED

launching the section, forms are placed on the lower three sides which form the keel.

In addition to erecting the steel, temporary wood bulkheads are placed while the sections are on the ways. These bulkheads are located 4 ft. back from the ends of the section and consist of 10x10-in. timbers set vertically, sheeted with 1x10-in. shiplap lumber and covered with an eight-ply waterproofing. Joints $\frac{1}{4}$ in. wide are left between the vertical 10x10-in. timbers to allow for swelling. The bulkhead is braced as shown in Fig. 11 by two vertical trusses 12 ft. deep. The top chords of the vertical trusses are 36-in. I-beams, as are the horizontal members which frame against the bulkheads. The trusses are designed to resist an effective pressure of 1,500 tons when the sections are in position on the bottom of the river.

The sections are launched sideways into the river. Launching ways are 12x12-in. timbers upon which the sections are supported in steel frame cradles to reduce the unit bearings on the ways and make launching easier. Load lines attached to hoisting engines gradually permit the sections to slide into the water.

In this condition, with the interior effectively sealed

FIG. 9—TWO STRUCTURAL STEEL SECTIONS BEING FABRICATED ON THE LAUNCHING WAYS

Section at right with bulkhead completed and keel forms in place is practically ready for launching. Note casting at horizontal diameter where connection to the next section will be made. In the section on the left, the bracing system for the bulkhead has been partly erected. X-bracing behind comprises the spiders placed opposite the diaphragms to round up the sections.

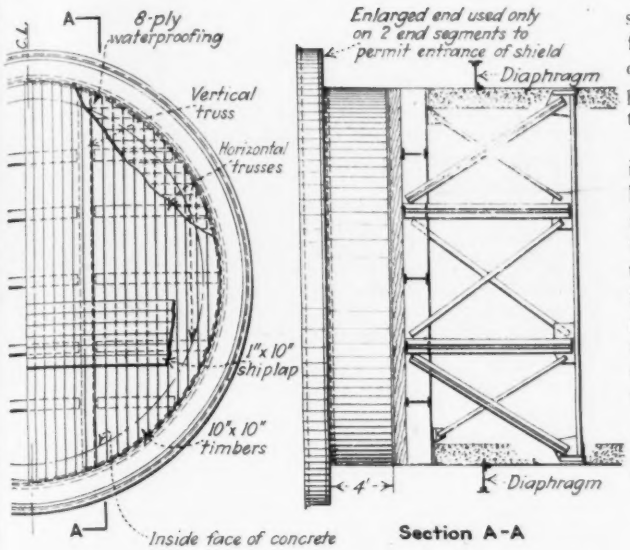


FIG. 11—DETAILS OF BULKHEAD IN SUBAQUEOUS SECTIONS

and with a draft of approximately 7 ft., the section is towed to an unused ore slip near by, where the first concreting is done. A view of these operations is shown in Fig. 12. After this first section was concreted, the original floating plant was abandoned and concrete was supplied from the land plant shown in the illustration. The hoisting tower for the latter plant has been ingeniously fashioned from old piledriver leads. Concrete is mixed in a 1-yd. mixer, discharged into a hoist bucket and elevated to sufficient height to allow it to be chuted across the track to the tunnel section. An industrial railway is laid on top of the section and the concrete car, which is pulled along by motive power on the shore, distributes the concrete to the point of placement, where it is dumped through manholes provided at the time of fabrication. In order to prevent segregation, the concrete is discharged into a hopper, from which it is chuted into the forms.

The concrete placed while the section is in the ore slip includes the inner 18-in. lining and exterior concrete for the keel, which is made up of the bottom and about one-half of the two adjacent sides. The inner lining is poured in ten separate operations, one of which includes the floor slab.

Following the pouring of the keel concrete, the section is completely inclosed with forms. In this condition it has an effective draft of about 23 ft. and is towed to a site nearer the tunnel trench, where greater depth of water is available to permit pouring the remainder of the tremie concrete for the outside incasement. At this site, about 800 ft. off the American shore, five clusters of piles lined in an up-and-down stream direction have been driven as an anchorage for the section. Lying up and down stream the section presents the least surface to the river current, which at this point runs at about 1½ miles per hour.

In completing the pouring of the remainder of the incasement concrete, unusual care is necessary to keep

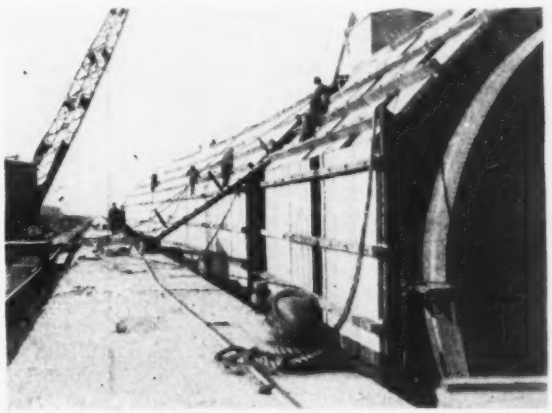


FIG. 13—INCLOSING FLOATING SECTION WITH FORMS PREPARATORY TO TOWING IT TO TUNNEL SITE
Note casting for joint in the right foreground.

the section balanced at all times. A double-tower floating plant is used and concrete is discharged into the forms on both sides of the section simultaneously. While the section is still at the mooring piles, two steel alignment masts are erected for the purpose of determining during sinking operations the exact alignment and elevation. These masts are left in place for a time after sinking in order to determine any settlement.

As soon as the section has been sunk low enough, barges are run over it at either end and made fast to steel lugs attached to the diaphragms. These barges provide an effective method of transporting the section to its position over the trench and finally assist in lowering it slowly to the bottom. As designed, the trench was made 20 ft. wide at the bottom with sides sloping upward on a 1:1 slope. Actual dredging has shown that the clay will stand on a much

FIG. 12—PLACING INTERIOR LINING AND KEEL OF CONCRETE
Concrete was chuted direct from tower plant in right background to hopper on top of tunnel section. Industrial car distributed concrete to manholes along section.

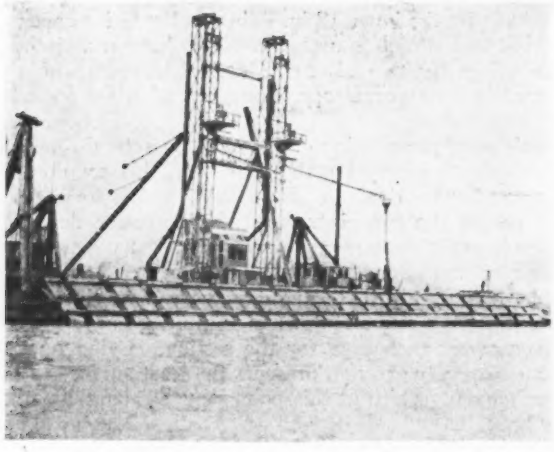


FIG. 14—PLACING TREMIE CONCRETE FOR INCASEMENT AND BALLAST

steeper slope and the side walls are now being excavated approximately ½ : 1. A 3-yd. clamshell dredge is being used to excavate the trench, which will require the removal of approximately 250,000 cu.yd. of clay. No unusually precise methods are being used in this trench excavation; site lines are provided by targets on building on each side of the river and divers inspect the trench from time to time.

One of the most interesting operations incidental to the subaqueous section construction is the placing of the sand bed in the bottom of the trench. Although designed to be approximately 1½ ft. deep, this bed is averaging closer to 2 or 3 ft. This sand is placed to correct grade by the use of a specially designed leveling device. It consists of a hollow rectangle of steel pontoons, the side pontoon being 70 ft. long spaced by four short pontoons at each end. Rails are placed on the long pontoon. Spanning these rails is a carriage suspended from which is an I-beam grillage attached to hand winches at the four corners. By means of these winches the grillage may be moved upward or downward, as necessary.

This leveling device is held lengthwise of the trench by four anchors. At each corner of the raft are suspended heavy concrete blocks. These are lowered to the clay bed and the cables pulled taut until the pontoons are submerged about 6 in. below their normal flotation, and the grade of the track is set to the same relative grade as is required at the bottom of the trench. Sand and gravel is then lowered in clamshell buckets to bring the fill to approximately correct grade and the carriage moved backward and forward until the sand is brought to its exact grade. This apparatus for leveling the sand bed is shown in Fig. 16.

With the sand bed prepared, tugs tow the section into place, where it is dropped as rapidly as practicable. Divers direct operations from the trench and insert pins in the joints at horizontal diameters. Following the completion of a section of the tunnel, the trench is filled to provide an effective cover of at least 4 ft. over the top of the finished structure.

To date six of the river sections have been successfully sunk, the shield-driven section in Detroit has been completed as well as the box subway section in both Detroit and Windsor. Completion of the entire project is expected late in 1930.

The tunnel is financed by and is being constructed for the Detroit & Canada Tunnel Company. Parsons, Klapp, Brinckerhoff & Douglas, of New York and Detroit, are supervising and designing engineers, with Burnside R. Value as executive engineer and Soren A. Thoresen engineer of designs. Ole Singstad is consulting engineer on ventilation. W. S. Kinnear is consulting engineer for the bankers.

The general contractor for the ventilation, terminals, box subway, buildings and approaches is the Parkland Construction Corporation, with Spencer, White & Prentis, of New York, and the Mark R. Hanna Company, of Detroit, as subcontractors. The general contractors for the subaqueous and shield-driven sections are Porter Brothers & Robert Porter, of Spokane, Wash., with the Canadian Bridge Company, of Walkerville, Ontario, the Northern Construction Company, of Montreal, Whitney Brothers, of Duluth, Minn., and the B. Sullivan Dredging Company, of Detroit, as subcontractors.

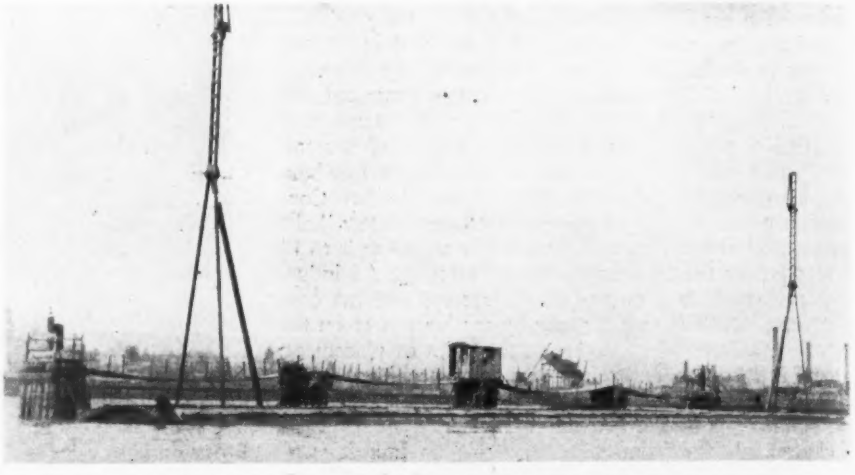


FIG. 15—SECTION BALLASTED TO WATER-LINE SHOWING CLUSTERS OF ANCHOR PILES AND TARGET TOWERS

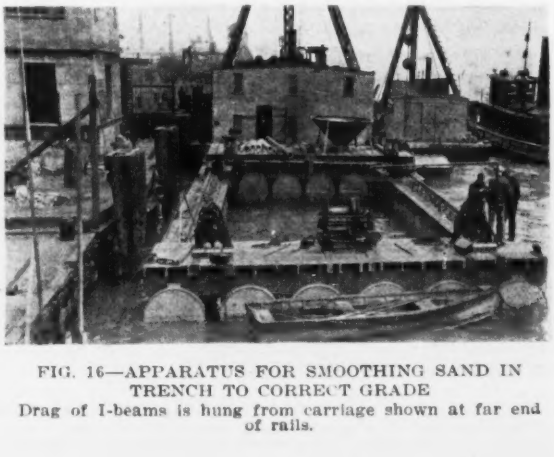


FIG. 16—APPARATUS FOR SMOOTHING SAND IN TRENCH TO CORRECT GRADE
Drag of I-beams is hung from carriage shown at far end of rails.

Dummy Joints Prevent Cracks in Seattle Concrete Pavements

Surveys Indicate That Joints of This Type Have Almost Eliminated Cracks That Show—Better Appearance and Longer Life

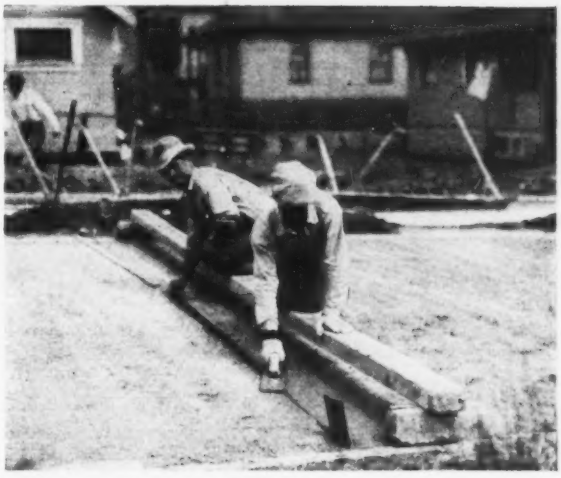
By H. F. Faulkner
Engineer of Physical Tests, Seattle, Wash.

THREE years ago transverse dummy joints were adopted by Seattle as standard construction on all concrete pavement. They have been eminently successful. Not only do recent crack surveys show a decrease in surface cracks of about 96 per cent but experience has proved that the great decrease in the number of through joints incidental to using dummy joints has made it possible to increase the durability and surface continuity of concrete pavements. Methods and results typical of Seattle practice are outlined in the following. A description of the dummy joint as used in Seattle along the pavement center line was published in *Engineering News-Record*, April 22, 1926, p. 646.

USING T-BAR TO MAKE DUMMY JOINT GROOVE
Bar is put down several times or until large aggregate is pushed away and the groove stands open.

Prior to 1926 the practice in Seattle was to use through transverse joints at 20-ft. intervals. This spacing probably is closer than would be required in many other parts of the country but was believed desirable because of the heterogeneous character of the local subgrade, which is of glacial origin, and also because of the annual saturation of that subgrade by heavy rainfall. Before the days of the thickened edge the joint created the most serious structural defect, corner weakness, in concrete pavement otherwise of adequate strength. It is still responsible for breaks in surface continuity with the resultant impact that is very likely to develop many corner breaks in the course of years when differential settlement along such joints occurs.

The complete separation of adjacent slabs in through joints is in marked contrast to conditions at the dummy joint. Even after cracking below the dummy joint has occurred, the adjacent slabs are keyed and interlocked by the irregular nature of the crack, and whatever change in surface elevation takes place is common and mutual to the two abutting slabs. A slight change in direction of the surface plane may occur, but abrupt discontinuity in the surface is impossible.



INSERTING PREMOLDED FILLER IN DUMMY JOINT
The vertical projection in the foreground is for the integral-cast curb.

Since the adoption of the 2-in. dummy joint spaced 15ft., the spacing between through joints has been increased to 30, 45 and 60 ft. The through joints are made with a ½-in. premolded filler, and sleeved dowels are put in to aid in maintaining surface continuity.

Full-depth transverse joints always introduce the problem of effective concrete placement against a transverse header, especially because of the presence of reinforcing steel. With the dummy joint, on the other hand, concrete placement continues without interruption and the joint is put in by a separate crew after the concrete gang has moved ahead.

The first operation in placing the dummy joint is to make in the freshly poured concrete a groove 2 in. deep by ½ in. wide on the line where the joint is desired. This is done with a T-iron worked by a two-man crew. It is to be noted that this plan would not be effective

LONGITUDINAL FLOATING OVER DUMMY JOINT
Dummy-joint fillers do not project and floating goes on over them. Through joint in foreground.

if concrete of excessive wetness were used. A premolded filler strip is then thrust down into the groove and a hand float is used to tamp the strip down and float the adjacent concrete so as to leave the filler flush with the surface of the pavement. Next, a two-man longitudinal float is used, working over the dummy joint as though it did not exist. The final operation employs a 6-in. edger with $\frac{3}{4}$-in. radius to tool the concrete along each side of the filler, thus smoothing up the concrete corner on either side of the filler.

The same procedure is employed for the longitudinal dummy joint, which is standard practice where the pavement is 16 ft. or more in width. All joints are tested with a 6-ft. aluminum straight-edge, and where

TESTING CONTINUITY OVER FINISHED DUMMY JOINTS
After tooling on both sides of the filler a 6-ft. aluminum straight-edge is used.

necessary corrections are made while the concrete is still in a plastic state.

Crack surveys do not indicate that reinforcing steel has had much effect in reducing cracks. It is believed, however, that the steel bars have functioned beneficially as dowels where straight through cracks have developed.

Despite the fact that some pavement, now three years old, has been placed on rather questionable subgrades, it seems to be in perfect condition where, as an experiment, through-doweled joints were put in at long intervals, ranging from 100 to 450 ft. apart, with intermediate dummy joints 15 ft. on centers. Where wide spacing of through joints has been tried they have been placed at street intersections and at abrupt changes of grade.

Under maximum temperature and moisture conditions the 1-in. width of joint between the long slabs is almost closed. Apparently, however, the movement takes place near the ends only, the middle portion of the length being held practically motionless by the friction of the subgrade and by axial compression. Crack surveys on dummy-joint pavements placed in 1926 show only 4 per cent as many cracks as occurred on pavement placed in 1925 with similar specifications except that through joints were on 20-ft. centers and no dummy joints were used.

The cost of pavement using dummy joints 15 ft. apart is less than the cost for the same pavement with through joints 20 ft. apart, and the delay of the concreting crew involved in the through joints is a considerable factor.

Moderate-Cost Testing Laboratory Proves Highly Efficient

North Carolina State College Builds Effective Materials-Testing Laboratory With Limited Funds

By Harry Tucker

Professor of Highway Engineering, North Carolina State College of Agriculture and Engineering, Raleigh, N. C.

THE civil engineering department of North Carolina State College has recently moved into a new building which has been specifically designed for its needs. It is located just east of the physics and electrical engineering building and at its south end is connected with the electrical engineering laboratory. In plan the building is a rectangle 193x61 ft., with the long dimensions north and south. It is two stories in height. The south end of the first floor is devoted to the testing equipment of the engineering experiment station; in the north end of this floor is located the materials-testing laboratory for civil, highway and construction engineering. The second floor is utilized for offices, classrooms and drawing rooms.

Due to lack of funds, it was realized when the building was being planned that the space devoted to the laboratory would be limited. Much thought was given to the arrangement of the rooms and the individual pieces of laboratory furniture and equipment, in order that instruction in the testing of materials could be given completely and conveniently in the space available. The laboratory, thus planned, has been used for two terms during the past session. It can be definitely stated that the arrangement has worked most successfully. It is quite likely that others who are planning materials-testing laboratories may be interested in a description of the arrangement that has been used.

A plan of the north end of the first floor of the building is given in Fig. 3. There are four rooms devoted to the testing of materials—the main laboratory room, a material and supply room, a conference room and a humidity room. The arrangement is unique and convenient, with the conference and supply rooms opening into the main laboratory room and into the corridor, thus affording ready access to any room from the others.

The main laboratory is a room 27x58 ft., with two laboratory desks, each 14 ft. long, with soapstone tops, central troughs and end sinks. Each desk has eighteen cabinets and drawers, which were built in the college

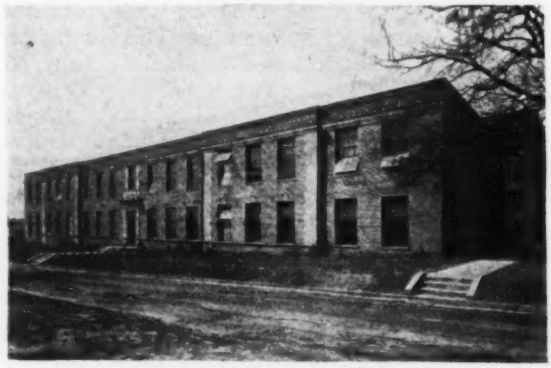


FIG. 1—NEW CIVIL ENGINEERING BUILDING AT RALEIGH

FIG. 2—EAST END OF MAIN LABORATORY

woodshop. The desks are placed with the sinks near the center of the room in order to avoid congestion with large classes.

Special testing machines and apparatus are placed on concrete pedestals as shown in Fig. 4. A chemical hood, with vent to the outside of the building, is in one corner of the room. Tables, each equipped with gas, are placed conveniently around the room, for the use of small pieces of apparatus.

All plumbing and wiring are concealed. The room is fitted with numerous outlets for electricity, gas, water, compressed air, and high- and low-pressure steam.

Built-in cabinets and bins are along the south wall of the supply room. There are 35 cabinets and seven bins, sufficient for the storage of all materials and supplies. The boiling apparatus is located in one corner of this room, as well as the analytical balances and electric oven.

The conference room is used for assembling the students, for outlining the work and for the further use of the students in working up notes and writing reports. A large blackboard extends along the entire length of the south wall of the room. It is believed that such a room is the most convenient adjunct to a materials-testing laboratory.

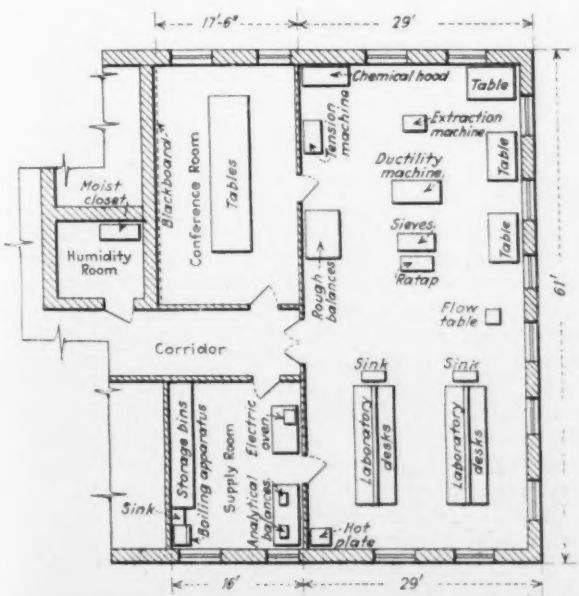


Fig. 3—FLOOR PLAN OF MATERIALS-TESTING LABORATORY

The humidity room is next to the conference room and opens on the corridor. It has unplastered brick walls and will be fitted up with apparatus for maintaining constant temperature and humidity. It will be used for the storage of test specimens in experiments on cements and concretes. A soapstone moist closet is located in this room.

A corridor extends north and south through the center of the building. At the south end of this corridor is the laboratory of the engineering experiment station, in which are located the universal testing machines, brick rattler, grinding laps, tire-testing equipment and stone cutting and testing machines. This apparatus and equipment is also used for instructional purposes and in connection with the materials-testing laboratory. The location of this room, adjacent to the electrical engineering laboratory, makes it possible to secure the various kinds of current needed for the different machines.

From the foregoing description it is apparent that

FIG. 4—SPECIAL MACHINES IN MAIN LABORATORY

a very complete laboratory can be provided for the testing of all materials used in engineering structures without requiring a great amount of space. A laboratory of this kind is almost essential to the proper teaching of many subjects included in any well-planned civil engineering curriculum.

Road Labels Aid Aviators

Marking highways for the benefit of aviators is recommended by the aeronautics branch of the U. S. Department of Commerce, which will soon issue specifications describing standard systems of marking for use throughout the nation. Roads, when viewed from the air, stand out clearly and form excellent landmarks when they can be identified. The department recommends simple markings involving in each instance the official route number preceded by the letters "U. S." in the case of federal highways, or by the state abbreviation for state highways. The symbols should be lettered directly on the pavement, using characters from 10 to 30 ft. in height, depending upon the pavement width. To insure uniformity, it is recommended that the markings read from west to east or from south to north, and that they be placed at all intersections with other highways and at intervals of not more than 20 (preferably 10) miles. Chrome yellow traffic paint is recommended for this use, although white paint is satisfactory.

Covered Stadium at Chicago With Long-Span Roof Trusses

Study of Sight Lines Leads to Simple Truss Roof—Cantilever Balconies—Methods and Progress of Erection

By C. H. Westcott
Vice-President, Westcott Engineering Company, Chicago

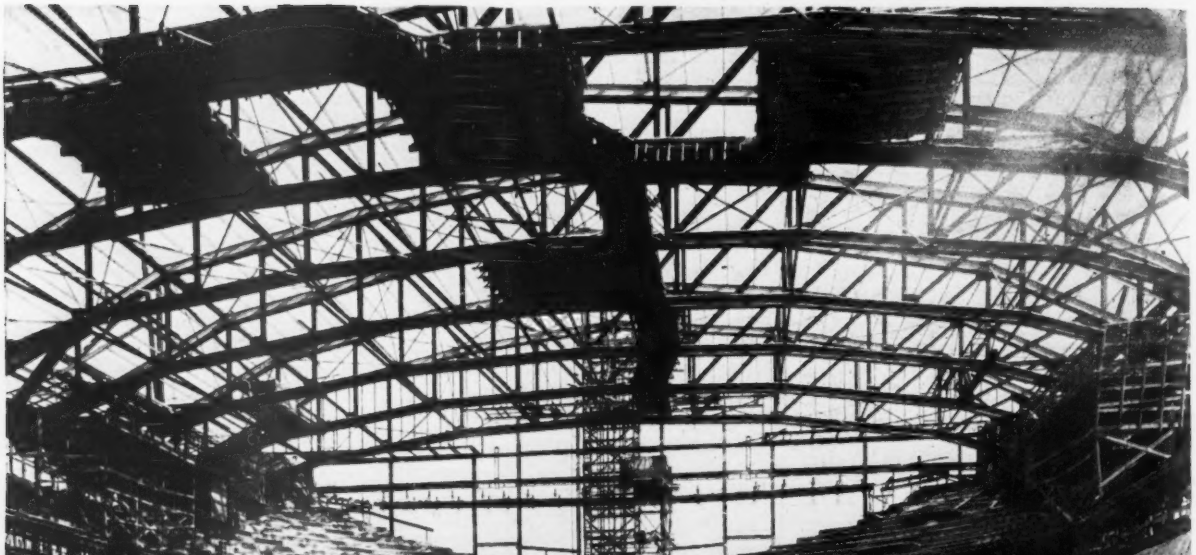


FIG. 1—LONG-SPAN ROOF TRUSSES

ROOF construction with steel trusses having a span of 261 ft. 9 in. c. to c. of supporting columns and spaced 25 ft. c. to c. is the most important structural engineering feature of the new Chicago Stadium, a commercial undertaking intended to accommodate various indoor sports. The erection of these trusses is shown by Fig. 2, and Fig. 1 is an interior view of the framing under construction. This building, 2 miles west of the business district of the city, is 300x266 ft., with a height of 117 ft. 6 in. at the high point of roof. The arena is 245x145 ft., with a clear height of 88 ft. Approximately 25,000 persons can be seated at boxing and wrestling matches, and 18,000 at hockey games and other sports which require the use of the entire arena. The main entrances are on the two parallel street sides. Center entrances serve the arena floor, and four corner entrances serve the first and second balconies, with a separate stair shaft for each balcony. A scissors type of stairway was used, thereby placing both runs in the same shaft. The stairs and emergency exits have sufficient capacity to empty the building completely in less than five minutes. Both street fronts are of Indiana limestone, with panels of cast stone near the top. The end walls are faced in brick to provide for future extension.

Foundations—The building is carried on 1,350 wood piles, averaging 50 ft. in length, with the cutoff varying from 3 to 5 ft. below city datum, depending on the basement grade. The piles are designed for a maximum load of 25 tons per pile, and no unusual soil conditions were encountered. A basement extends under the entire building, except the arena, and a ramp roadway serves the basement level on the west side.

Typical Construction—Above the main or arena floor there is a mezzanine floor and a first and second balcony, the highest seats in the balcony being 66 ft. above the arena floor. This is shown by the typical section, Fig. 3. Great care was given to the sight lines for each particular sporting event to be accommodated, so that there would be no "blind spots" for any seat. Two factors governed the layout of the sight lines: (1) a view of the entire bicycle track, and (2) a view of aerial circus performers from any seat in the building. These are extreme specifications to carry out in a structure of this type.

In general, the building is of steel frame construction, with reinforced-concrete seats and risers, which are 2 ft. 8 in. wide with a rise varying from 1 ft. to 2 ft., depending on the sight lines. The concrete risers form beams which span 25 ft. between cantilever girders. These concrete seat banks form an effective bracing sys-

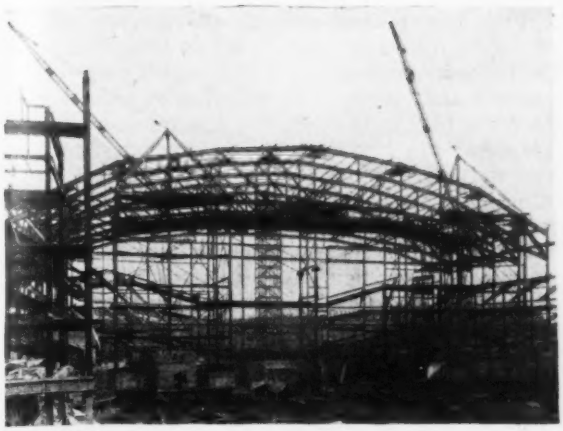


FIG. 2—ERECTING ROOF TRUSSES, CHICAGO STADIUM

tem between the girders and stiffen the building in a manner similar to the floor system in the average structure. The overhang of the cantilever girders varies from 18½ ft. at the sides of the building to 24 ft. at the ends. The ends of the building are designed to permit enlargement, and removable balcony sections are provided there to permit the entrance of large displays, such as airplanes and power boats.

Ventilation is accomplished by four complete air-conditioning units in the corners of the building just below the roof. A capacity of 600,000 cu.ft. of air per minute is diffused down over the audience and returned through vents in the seat risers. Refrigeration is provided, with a total capacity equivalent to 600 tons of melting ice each 24 hours. Water may be pumped through the cooling units for the purpose of cooling the air in the air-conditioning system, or brine may be circulated, as indicated in Fig. 4, in order to freeze the skating surface of the arena floor.

Truss Roof Construction—The roof is the most interesting feature from a structural engineering standpoint. The reason for the selection of a clear span truss rather than a two-hinged or three-hinged arch truss was the requirement that every seat must have perfect sight lines, with no interference. This prevented the use of a deep arch truss member, which would be desirable from other standpoints. The trusses vary in weight, depending on the design loading, from 90 to 105 tons. Their depth is 28 ft. at the center and 15 ft. at the ends, with a bottom chord rise of 21 ft. 6 in. The typical bottom chord members are of box section with two vertical web plates 22x⅜ in. and four angles 4x4x½ in. Typical top chord members consist of two web plates 22x½ in., two angles 4x4x½ in., two angles 6x4x⅜ in. and one cover plate 26x⅜ in. Web members are 12-in. H-beams.

A complete system of vertical and lateral angle bracing is used, with the bracing placed in alternate bays to avoid interference with the organ rooms and to permit of purlin expansion joints at two points in the length of the building. In order to secure a lightweight roof deck, pressed steel sheets with 1 in. of cork insulation were adopted. The sheets are pressed out of No. 20 metal, with a span of 6 ft. 5¼ in. between 10-in. channel purlins. Provision is made for a future ceiling of a similar type.

A large pipe organ is being installed at the center of the building, in the space afforded by the depth of the trusses (see Fig. 3). Its pipe towers, because of their length of 64½ ft., are to be laid horizontally. The organ blower has a capacity of approximately 100 hp. and is estimated to have the volume of 2,500 orchestral pieces. An electrically operated winch is installed at the center of the building to raise and lower the ring lights.

Loads—A live load of 100 lb. per sq.ft. was used throughout, except 150 lb. for a portion of the main floor. A horizontal wind pressure of 20 lb. per sq.ft. of exposed surface was assumed. A snow load of 25 lb. per sq.ft. was used in the design of the roof trusses, and the machinery loads for the ventilating and organ equipment were given special consideration. The design roof load, independent of machinery, was 67 lb. per sq.ft., made up as follows: live load, 25 lb.; truss and bracing, 29 lb.; purlins, 3 lb.; roof deck, 5 lb.; ceiling, 5 lb.

The partitions were 8-in. brick walls in most cases and were carried on special framing rather than to include a unit partition load item to be figured on all floor slab areas.

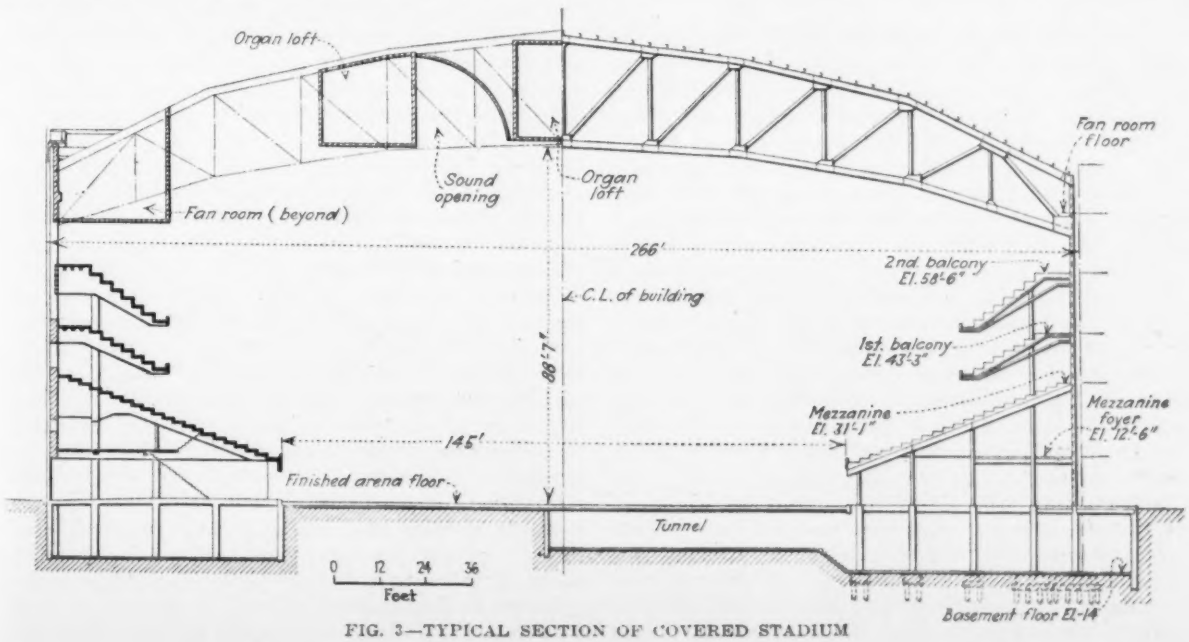


FIG. 3—TYPICAL SECTION OF COVERED STADIUM

Erection Progress—Three power shovels and two piledrivers were employed to expedite the foundation work. The first shovel started July 9, 1928. During erection of the main floor steel and pouring of the concrete floor construction, work was started on the erection of the two main travelers, on property adjacent to the east of the building. These travelers were two towers, 82 ft. high, 60 ft. long and 45 ft. wide, connected by a bridge of 94-ft. span. Each tower was rigged with a stiff-leg derrick with 90-ft. boom, and was counterweighted at the base with 20 tons of brick in addition to the machinery loads.

Erection of the balcony and mezzanine framing, together with the corner stair towers, preceded that of the roof trusses, and this work was handled by two smaller

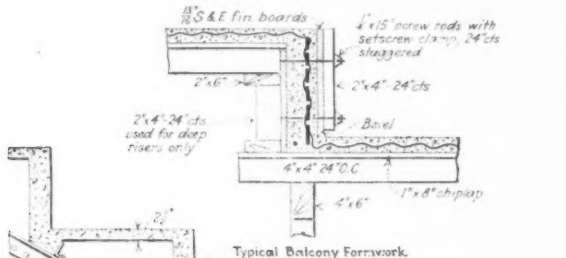


FIG. 4—SPECIAL STRUCTURAL DETAILS
Top—Balcony formwork. Middle—Balcony girder and floor. Bottom—Arena floor with freezing pipes and insulation to provide for ice skating.

derricks operating on the ground and fed by a crawler crane. Steel rails were laid west from the travelers onto the main floor slab, and after this slab had been carefully shored up from below, the travelers were rolled into place in line with the first two main column centers. The travelers were designed to fit the 25-ft. panels, so that two trusses could be erected at once and be securely braced to each other before releasing the blocks and moving on to the next position. The bottom and top chords were each handled in six sections, and the web members were erected singly. The entire truss was riveted and the lower connections to the columns were securely bolted before the blocks were released and the traveler moved. Then, after the dead-load deflection of the truss had taken effect, the top column connections were reamed out and the rivets in all end connections driven. An erection camber of 3½ in. was adopted and proved to be entirely satisfactory.

Erection was pushed vigorously during the winter, in spite of the worst construction weather that Chicago has experienced for several years. The structure required 3,300 tons of structural steel, 5,000 cu.yd. of concrete, 4,200,000 bricks and 35,000 cu.ft. of stone.

Truss erection started Nov. 22, 1928, and on March 28, 1929, the building was officially opened. Figs. 1 and 2 show the stages of the work on Dec. 27 and Jan. 31. In order to accomplish this rapid progress, the mezzanine and balcony concreting had to follow closely behind the roof truss erection. Winter concreting was made possible by heating both water and aggregate with steam coils, so that the concrete as poured had a temperature of about 70 deg. F. Complete canvas inclosures were placed on all sides to protect the thin slabs and finished surfaces. As many as 250 salamanders were kept burning at one time in order to maintain a temperature of 60 deg. F. Quick-hardening cement was used in the organ-room floor slabs, to secure early removal of forms and because of the difficulty of maintaining heat at that elevation.

Considerable time in formwork was saved by the balcony riser design shown in Fig. 4. The lower platform was first set in place, then the riser form, which had been made in the shop on the site, was placed on the platform. Then the next platform was set, and so on, up the bank. The use of screw rods with clamp to hold the facia boards proved to be a great improvement over the old system of using through bolts. The exhaust ventilator frames, made of sheet metal and light angles, served to some extent as riser spacers to hold the facia boards at the proper distance from the back form. It required an efficient field organization to put the building in active service by March 28, and the entire building was erected without a single loss of life or major accident of any kind.

Personnel—The architectural design was prepared for the Chicago Stadium Corporation by Hall, Lawrence & Ratcliffe, architects. The general contractor was the J. W. Snyder Company, with R. F. Kirkman, vice-president, in responsible charge. The erection was accomplished by the Strobel Steel Construction Company. The Westcott Engineering Company designed the structural steel framing, the reinforced concrete and the foundations for this building.

Citizens' Advisory Committees in Chicago

Chicago and the Chicago region have been obtaining excellent service in initiating large highway improvement programs through citizens' advisory committees appointed by governmental heads. Cook County has long used the method of setting up programs, and recently the Governor has resorted to the same procedure in laying out a program for the expenditure of large sums to be obtained from the recently voted 3c. gas tax, 2c. of which goes to the state and 1c. to the counties. The West Park Commissioners have had such an advisory committee made up wholly of engineer citizens to help it lay out in a preliminary way and promote an elevated highway from the loop or downtown business district west to the city limits. The city has under way a settlement of the rapid transit franchise problem that seems now to have been brought to a head by a citizens' committee. In working out the highway problems generous use is made of the facilities and experience of the staff of the Chicago Regional Planning Association, of the technical staff of the Chicago Association of Commerce and that of the motor clubs, so that the results are not so amateurish or political as might at first appear. In all of these committees engineers are finding appointment and are serving the community as citizens from the viewpoint of their profession.

Civil Engineers at Boston Meeting Discuss a Program of Regional Papers

Metropolitan Engineering, Educational Aspects, Research Reports, Highway Economics and Traffic Control and Relief Features of Balanced Program

Engineering News-Record Staff Report

WITH New England educational and historical experience as subjects of a carefully developed list of papers, there resulted a practical and useful program at the Boston meeting of the American Society of Civil Engineers Oct. 9, 10 and 11. Upward of 600 people registered, more than 90 per cent coming from New England. Regional engineering of the Boston metropolitan area in all its phases formed the keynote of the general sessions, since Boston is the cradle of the metropolitan unity idea, evolved to effect relief from ills having an engineering basis. The City Planning Division carried the local views still farther in its program on early planning of the city and region. Local educational influence was felt in the Structural Division in a soil research paper and in the Highway Division in papers on Massachusetts highway beautification and standardized traffic factors and in three papers in the Surveying and Mapping Division, all of which dealt with local or near-by matters.

The general session papers related specifically to development of the district as a metropolitan whole, its administration, the park system, the water supply, sewerage and transportation. The technical work was so concentrated in the five Thursday division sessions, unfortunately, that any one member could attend only two division meetings. With broad interests in the general sessions and with a number of strong technical and research papers in the division meetings the program was well balanced.

A brief account of the division proceedings follows.

Boston as a Capital City

City Planning—In the second of a series of papers on capital cities before the City Planning Division, Arthur C. Comey, consulting engineer, Cambridge, Mass., outlined the history of Boston's development and growth for the last 300 years. The chief justification of this series, which began with Denver, lies in the inspiration and guidance which the capital city exerts through its example on the other cities of the state. Except for the Capitol building the fact that in Massachusetts the government is located in Boston is but an incident so far as its effect on the city plan is concerned, but the city was never planned in any great degree; it reflects its history no more strongly than any other element. Many steps have been taken toward broad planning, but only in recent years has any material progress been accomplished. Street widenings have cost more than $40,000,000, and some have been three times repeated. Today the central authority on planning matters is an official Planning Board established under a compulsory state law in 1914. This board is about to publish a comprehensive major street plan. Other factors in Boston's plan, noted by Mr. Comey, relate to (1) land drainage, by which is meant largely the development of the watercourses, such as the Fenway and Charles River; (2) docks and wharves, with the new East Boston airport, fifteen to twenty minutes from the heart of the city; (3) the railroads; (4) mass transportation by the street railways and rapid transit lines; (5) water and sewerage, which have had little effect on the plan, and (6) recreation facilities.

Two factors of administration have exercised a vital effect on the metropolitan plan; these are the region's relation to the state and its separation into 39 municipalities, with all of the usual difficulties and advantages of predominant control and satellite development in an unusual topographical location.

An outline of the professional training for the practice of city planning, with particular reference to the course at Harvard University, was presented by Henry V. Hubbard, professor of regional planning. Requirements for a degree are 3½ years' work, and entrance requirements are graduation from an academic college course or something less for technical graduates.

John Nolen, in discussion of the Comey paper, emphasized that Boston, while apparently a historical and staid city, in reality should be noted for its urge for change, since it has been a pioneer in many city plan movements. It was the first to have a subway, first to finance, build and operate regional projects in metropolitan districts. He considered Boston as a sort of municipal laboratory for New England as well as for other cities of the country. In this example of change Boston can be looked upon as a capital city of wide influence, since engineering knows neither political boundaries nor geographical location.

Necessity of Broad Vision Stressed

Robert Whitten in his discussion of the same paper cited the necessity of broad vision for long-time possible development, though for practical reasons the immediate future requirements are all that can be put before the public for adoption. Boston needs north and south through express routes, now in the course of attainment. Analyses of the origin and destination of 188,000 drivers from 69 districts indicated 2,273 destinations; further the volume of the pairing of these 69 districts was inversely as the square of the distance and directly as the number of resident motor vehicles licensed. Particularly valuable was Mr. Whitten's comment to the effect that widenings and other improvements for express highways should be developed only after definite economic factors of value to the traffic rather than to the abutting property had been determined. Motor-vehicle-miles per year was the unit he suggested as a basis, using 10c. per mile as the cost of operation.

Charles R. Gow, contractor, engineer and postmaster of the Boston district, presented practical methods for city planners to use in educating public officials to the adoption of their projects. Particularly should city planning experts back up one another,

thereby giving the inexpert layman less chance to succeed in obstructing the adoption of well-considered projects, though the proposed development may not be wholly agreed to in many details.

Highway Division—Following a program of discussing at several of the recent quarterly meetings the apportionment of gasoline and license fee moneys there was presented by George H. Henderson, chief engineer, Rhode Island State Board of Public Roads, a paper giving the state highway department views. No new arguments for allocation of the funds entirely to the state were presented either in the paper or in the written discussion by F. E. Everett, state highway commissioner of New Hampshire. As Mr. Henderson admitted, few facts exist and unsupported opinion is therefore all that can be given. Divergent opinions based equally on lack of fact were presented in discussion by city representatives. Frank O. Whitney, connected for 50 years with Boston street projects, well summed up the situation in stating that when the state highway departments locate and build continuous trunk lines regardless of city boundaries in accordance with the needs of other than local traffic the apportionment of general funds will automatically be equitable.

Beautification of Highways

Massachusetts has a highway landscape supervisor to look after the beautification of its highways. James H. Taylor, who holds this position, spoke of the efforts being put forth to get more "flow" into highway alignments, bridge and guard rails, more co-operation in cleaning up the roadside by contractors after completion of their contracts, removing junk and trash piles, and proper planting to enhance the natural landscape beauty of the roadside.

The standard code for traffic control signal installation and operation, recently prepared for the State of Massachusetts by Miller McClintock, was explained as to engineering principles involved and as to definite standard and uniform requirements. These the state highway department will soon begin to enforce.

Surveying and Mapping Division—Papers in this division related to surveys for the new Swift River reservoir of the Boston Metropolitan District water supply, to leveling for tunnels and reservoirs of the district and to triangulation in the state and its connection with land court registration.

Lake Champlain Bridge Discussed by Structural Division

Two papers on leading subjects of current interest occupied the session of the Structural Division and held the close attention of a gathering of 150. They dealt with the recently opened toll highway bridge over Lake Champlain, built by the states of Vermont and New York, and with current research in soil physics. Discussion was largely limited to prearranged speakers.

Prof. Charles M. Spofford, of the firm of Fay, Spofford & Thorndike, engineers of the Champlain bridge, outlined the general design of this unusual structure, which makes the first break in a water barrier 120 miles long separating the two states. Public demand and state policy led to the adoption of the public toll plan of construction. The foundation depth, about 100 ft. to rock in the middle part of the half-mile crossing, led to the choice of a 434-ft. main span, and navigation requirements necessitated a 90-ft. vertical clearance over the channel. Because of these conditions, in conjunction with low shores and the desirability of cantilever erection of the channel span, the type of structure and arrangement of spans were studied in much detail. The result was the adoption of continuous spans in the channel section, in preference to a cantilever, for both economy and rigidity. Continuous construction was also used for the larger auxiliary spans. The bridge roadway is of concrete, with separately placed concrete wearing surface, and is provided with a double or stepped curb topped with cable-and-mesh guard railing. The bridge cost only $1,200,000, all included. According to F. H. Fay, traffic over the bridge has proved to be about double that estimated as a basis for tolls, and if the rates are maintained promises to refund the cost in twelve to fifteen years.

Unusual Problems Encountered

Foundations and superstructure erection of the bridge both presented unusual problems. The former were reviewed by George W. Burrows, who was in charge of the pier work for the Merritt-Chapman-Scott Corporation, contractor. In the bidding, open cofferdam construction proved to cost only three-fourths as much as pneumatic caisson work. The cofferdams actually used were single-wall inclosures of steel sheet-piles spliced to 98 ft. length and sealed by concreting under water after excavating by dredge bucket and washing the rock bottom clear by jets directed by a diver. The sheeting was proportioned for a bending stress of 16,000 lb. per sq.in. and the steel bracing for 20,000 lb. combined stress, with liberal estimate of wind pressure. H. W. Troelsch, assistant engineer of the American Bridge Company, described the erection, which was done in winter. For the principal side spans isolated pile clusters at large spacing were used, cantilevering as much as feasible. This work required piles 145 ft. long, which were made of 12x12 timbers spliced by four corner angles. In building the halves of the main span as cantilever extension from the adjacent spans (with which it forms a three-span continuous structure), the outer ends of the latter were dropped about 2 ft. and the expansion side was set forward several inches, to provide a clearance of 2 or 3 in. in both top and bottom chords at the time of closure. After closure and adjustment of position, the pier reactions were brought to the theoretical amount by hydraulic jacks equipped with gages.

J. W. Rollins, Jr., of Boston, discussed some of his experiences in deep pier construction, including the sinking of open caissons 132 ft. at New London and 135 ft. at Poughkeepsie. For the Champlain conditions he suggested that open caissons formed of a two-wall braced shell, with the whole interior open, might have been found suitable.

Laboratory Research on Soils Assists Practice

A stimulating review of four years of research in soil physics at Massachusetts Institute of Technology, given by Dr. Glennon Gilboy, brought to light the intimate bearing of modern soil research on many major problems of engineering practice. The research program was initiated by Dr. Charles Terzaghi on coming to Cambridge from Robert College, Constantinople, in 1925. Dr. Gilboy, Dr. Terzaghi's collaborator, will continue the work now that the latter has left to assume a professorship at Vienna in the same subject.

Determination and measurement of characteristic physical properties of various types of sand and clay

were the objective of most of the laboratory work. Special apparatus was developed for measuring load and time rates of compressibility, the consolidation, the permeability and the internal friction. These quantities were correlated with service behavior of soils in foundations, subgrades, dams, retained fills and other soil structures. Extensive co-operative work has been done with the U. S. Bureau of Public Roads, the New England Power Association, the Miami Conservancy District and various other corporations and engineers.

One of the most decisive demonstrations of the value of laboratory studies of soils was obtained in the case of a group of warehouse buildings founded on piles driven in a great depth of soft soil, which developed large settlements. Borings showed the presence of soft clay strata at considerable depth. On laboratory study of the consolidation of this clay under load, the settlements of the buildings could be calculated, and these calculations checked the observed settlements with surprising accuracy. The piles in no way contributed to the support of the buildings, it was found, and therefore represented useless expense.

As part of the investigation of earth dam structure, studies of the hydraulic core of the Germantown dam of the Miami Conservancy District have been carried on. A test pit dug down through this core shows that the material has undergone only about 25 per cent consolidation in the ten years since its placing, but is nevertheless stiff and stable because of its high internal friction resulting from effective grading.

Large-Scale Retaining-Wall Test

The most elaborate item of the soil research to date is a large-scale retaining-wall test, carried out in a concrete bin 14x14 ft. in plan and 7 ft. deep, proportioned for great rigidity and with careful attention to all the factors that influence the pressure of earth confined in such a bin. This work, the results of which are to be published at a later date, was undertaken to guide the design of a retaining wall about 160 ft. high which will form the junction of the earth body and the spillway section of a dam now under construction.

Frost heaving has also been investigated, and the results show that, in accordance with views previously held by some, heaving is due not to the freezing of the water originally present in the soil but to successive freezings of water drawn up into the frost zone by capillarity.

The paper was briefly discussed by C. H. Eiffert, chief engineer of the Miami Conservancy District; George Paaswell, engineer of the Corson Construction Company; Prof. C. M. Spofford, and President Anson Marston. Mr. Paaswell drew attention to the important bearing of soil study on excavation problems, where the entire excavation program, choice of machines, and method of sheeting and bracing, are dependent on the soil properties in a way often beyond the reach of empirical determination.

Evolution of Adjustable Blade Hydraulic Turbines

In a lecture of unusually strong appeal Prof. D. Thoma, of Munich, Germany, outlined the experimental and practical development of the Kaplan turbine, a propeller-type turbine with adjustable blades controlled by a governor. The field of service of this turbine is low-head work where high specific speed and capacity is essential and where high efficiency over a large load-range is important. Whereas the fixed-blade propeller turbine has been found to give high full-load efficiency with a sharply peaked efficiency curve, the adjustable-blade type gives a flat-top curve of equally high maximum and with a wide range of efficient operation. Maximum efficiencies as high as 95 per cent were cited.

The largest turbines of this type to date are the four wheels of the Ryburg-Schwörstadt power plant on the Rhine, between Switzerland and Germany. The runners are 23 ft. in diameter, and discharge 11,000 sec.-ft. under 39½ ft. head. Still larger turbines, 26 ft. in diameter, are planned for a Swedish water power.

In the practical development of the Kaplan turbine, after its value had been demonstrated by laboratory tests and small installations, special problems lay in the rotatable support of the blades in the wheel hub and the governing mechanism. Two governors are used, one for the guide vanes and one for the wheel blades, interlinked at the pilot valves. In the latest wheels the blade movement is actuated by an oil-pressure plunger built into the coupling between turbine and generator and moving the blades by a rod passing down through the hollow center of the shaft to the interior of the conical housing which covers the lower end of the shaft below the wheel.

Proposals for Engineering Service

Ill-informed city authorities still occasionally call for competitive bids for engineering services, and a recent case is described in the *Illinois Engineer*, which is the bulletin of the Illinois Society of Engineers. It quotes an article published in a local newspaper at Aurora, Ill., some parts of which are given below, omitting names.

One attorney and two engineering firms submitted bids to the board of local improvements today in response to the recent action of the board to advertise for bids on a contingent fee basis, for such engineering and legal work as the board may specifically designate to be done by outside engineers and attorneys during the ensuing year. The bid on the legal work was 2 per cent of the total cost of the improvements to a point where the fees would aggregate $7,500 and then 1½ per cent until the total fees would aggregate $12,000. The maximum under his bid would be $12,000 and the minimum $5,000.

Two engineering firms submitted figures. One company bid 2¾ per cent of the cost of the improvement under one set of specifications and 4½ per cent under another. Under the bid of 2¾ per cent the company would make all surveys, estimates, preparation of plans, preparation of engineering sections of the resolution and ordinance and other routine engineering service. It does not, however, provide for the detailed specifications on which a contract is based. The 4½ per cent bid includes the drawing of detailed specifications and the supervision of the work throughout the period of construction. No provision is made, however, for payment of inspectors.

The bid of the other company (a local concern) was made on a daily wage basis of $16 for first assistant engineer, $12.50 for second assistant, and $8 for third assistant engineer. Mr.—— in an explanation of his bid, stated that by placing it on a per diem basis the city would be able to refer to him only such work as could not be done by the regular engineering department of the city. A third company forwarded a reply to the advertisements for bids, but declined to make a definite bid, contending that, in its opinion, professional services entailed more than the mere statement of a specific amount for which a job would be done.

The city engineer told the council that, in his opinion, there is some misunderstanding as to the need for outside engineering work at this time: "It has been the practice to let out engineering work only at such times as the press of work in my department made it impossible to press through a certain job as expeditiously as the board wanted. In those cases it was only such work as comes prior to the letting of a contract that has been let out. My department has always handled the work during the period of construction. At the present time I do not see that we are particularly in need of any engineering service outside of my regular department."

Crawler Trailer With 9-Cu.Yd. Body Used at Rockfill Dam

Large Size Tractor-Trailer Equipment Used for Short Hauls—Body Weighing 6 Tons Designed for Rough Usage

By Hector Keesling

Assistant Engineer, General Construction Department, Pacific Gas & Electric Company, San Francisco

CRAWLER trailers with a capacity of 9 cu.yd. drawn by crawler tractors are being used for hauling the spillway excavation to the fill at the Salt Springs rockfill dam under construction by the Pacific Gas & Electric Company on the Mokelumne River, California, as a part of a power development program. The specially designed bodies are mounted on 20-ton truss-wheel trailers and are equipped for end dumping by means of hydraulic hoists controlled from the tractor. These units were selected to handle the rock from the secondary quarry under conditions which included short haul and frequent shooting in the quarry, which made rail equipment impracticable. Railroad equipment with storage-battery locomotives is used to move rock from the main quarry where the haul is longer and the quantities are larger.

The trailers are a modified form of common truss-wheel design, strengthened to meet the severe operating conditions. The additions included a stiffened steel frame, double truss rods, high-carbon heat-treated steel axles and a spring-cushioned type of swiveled coupling designed to lessen shocks to the trailer and those transmitted to the tractor during loading and dumping.

The bodies were designed and constructed with the minimum of weight permissible for hauling rock in order that the proportion of pay load to total load would be as high as practicable. The frame consists of ribs of 6-in. channel irons in pairs on 18-in. centers, bent to form a body 8 ft. wide at the bottom, 2 ft. 6 in. high and 11 ft. wide at the top, as shown in the accompanying drawing. The first bodies were built 12 ft. 4 in. long and the length was later reduced to 11 ft. 7 in. The lining consists of ¼-in. steel plate covering the bottom, sides and forward end; the rear end of the body is left open. On the floor this lining is covered first by a 2-in. layer of hardwood to act as a cushion. On this planking rests the steel bottom plate, ½ in. thick, which in turn is protected by removable steel wearing strips on 14-in. centers. Use of these wearing strips has proved successful in protecting the bottom plate from excessive wear and in causing the larger rock to slide more readily in dumping.

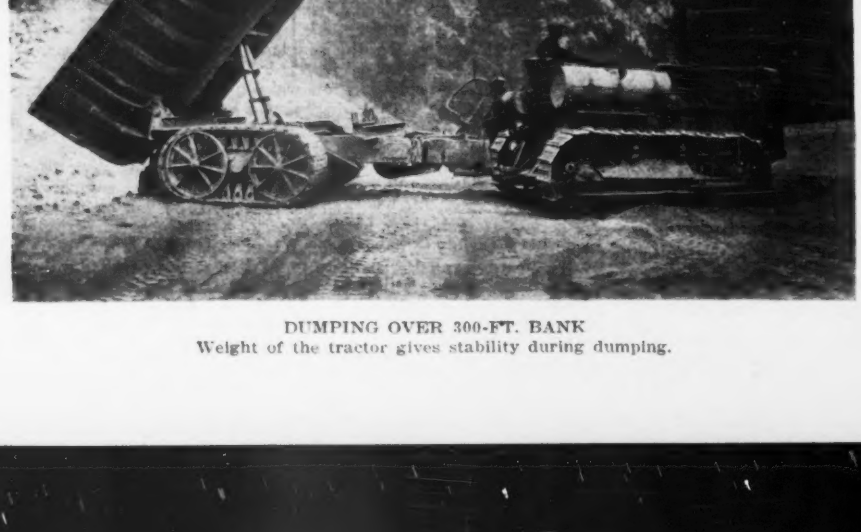
Dumping is done by means of a telescoping hydraulic hoist operated by oil supplied through flexible hose from a pump located on the tractor. The pump operates by power takeoff from the tractor engine and is controlled from the operator's seat. The arrangement of hose connections shown in the accompanying illustration was that installed on the first trailers. This feature was later improved by running the hose through the trailer frame just above the coupling, giving a more practicable arrangement.

TRAILER BODY OF 9-CU.YD. CAPACITY
Note stop block at edge of dump.

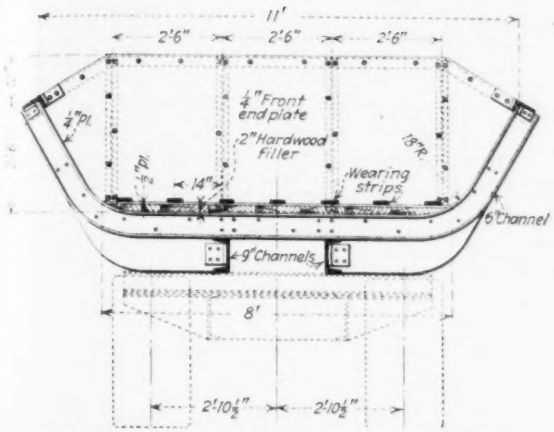
This type of hauling unit was selected because it was believed to be more rugged and to have a greater capacity than any other form of equipment, only excepting that operating on rails. In addition to quick loading and large capacity, these units actually travel as fast as trucks in this particular work because of the short haul and excessive turning. Dumping over a bank nearly 300 ft. high, the stability which the weight of the tractor gives during dumping made this unit safer than a truck against loss over the dump.

Cost analysis showed that investment for equivalent truck equipment would be about the same, but operating, maintenance, depreciation and fuel costs showed an advantage in favor of crawler-trailer equipment. With the large amount of turning required, it was estimated that cost of repairs to the tractor and trailer tracks would be less than the cost of truck tires.

Selection of this equipment for the particular conditions on this job has proved satisfactory, although the cost of putting rock in the dam by this method has been slightly higher than the cost at the main quarry with railroad equipment. In a case of long haul where the



DUMPING OVER 300-FT. BANK
Weight of the tractor gives stability during dumping.



SECTION THROUGH TRAILER BODY, LOOKING TOWARD FRONT END

volume did not warrant railroad operation, trucks might have competed successfully with tractor equipment.

The design of the body was the result of the joint effort of the Athey Trailer Company, the Mutual Engineering Company, of South San Francisco, and the general construction department of the Pacific Gas & Electric Company.

Pulverizing and Screening Dried Sewage Sludge

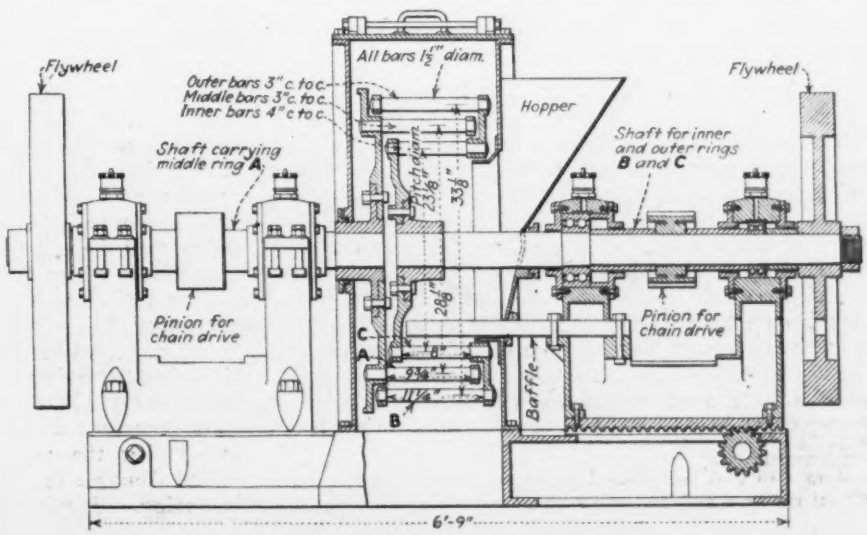
Fertilizer Made by Passing Sludge Over Vibrating Screens—Oversize Reduced in Disintegrators—Costs

IN THE manufacture of a commercial fertilizer from sewage sludge at the plant of the Milwaukee Sewerage Commission, the dried sludge is passed over inclined vibrating screens, the material passing through these being the finished product, while the oversize is delivered to centrifugal pulverizers or disintegrators and then returned to the screens. This dried sludge, which is both corrosive and abrasive, ranges in size from dust to ⅜-in. particles, and is composed largely of hard pellets that are difficult to pulverize. Occasionally it is sticky, but this is the case only when the operation of the driers is not quite satisfactory, so that their product includes balls which still contain considerable water. There are four screens and two disintegrators, one of each being held in reserve. Each screen has two 4x6-ft. vibrating elements and two screening elements of the same size with mesh of 0.065 in.; the total screening area for the three machines in operation is 144 sq.ft. Vibration of the screens is to prevent clogging and insure thorough separation of fine stuff from the oversize material.

Pulverizing is accomplished by passing the material through concentric squirrel-cages composed of steel bars, the three alternate cages revolving in opposite directions. Each machine has three rows or rings of bars, as shown in the accompanying drawing. The shaft of the two-row cage, carrying the inner and outer rings, is driven at 500 revolutions per minute by means of a silent chain and 20-hp. motor. The one-row cage, carrying the intermediate ring, is driven in the opposite direction, so that while its actual speed is 500 revolutions per minute, the relative speed of the rings is 1,000 revolutions per minute. A 25-hp. motor was used for this intermediate ring, but this is to be changed for a 15-hp. size, as tests show the power input to be about 18.5 hp. As the material flows in from the hopper it strikes a baffle which deflects it against the inner row of bars and also prevents it from setting up a whirling motion within the machine. A flywheel on each shaft prevents shock to the mechanism when heavy masses of sludge fall into the machine.

All the bars are 1½ in. in diameter. In the outer ring or cage, 33⅛ in. in diameter, the bars are 11¼ in. long and spaced 3 in. center to center. In the middle ring, 28⅛ in. in diameter, they are 9¾ in. long, with the same spacing. The inner ring has a diameter of 23⅛ in. with bars 8 in. long and 4 in. center to center. Owing to the character of the sludge there is somewhat rapid wear of the bars. Mild steel bars were badly worn after two weeks, while worn bars covered with ⅛ in. of stellite have an estimated life of eight months, and still longer life is expected from bars of high-manganese chromium-steel which are now being tried.

During the first four months of 1929 the output of finished product was 11,256 tons, or an average of 93.8 tons daily. On this daily basis and allowing for power, depreciation, fixed charges and operation, the cost of pulverizing is estimated at 10.2c. per ton of finished product and 12 to 17c. per ton of material handled, while for screening the costs are estimated at 15.3c. and 8 to 9c., respectively. The cost per ton of finished product is the most useful figure, since the amount of material handled through the screens cannot be determined definitely. The three screens handle 150 to 175 tons in 24 hours and the pulverizer handles 55 to 80 tons. In this analysis of cost, made by the A. C. Nielsen Company, Chicago, for the manufacturers of the machinery and the Milwaukee Sewerage Commission, the total investment cost is given



DISINTEGRATOR FOR SEWAGE SLUDGE

as $15,885 for the screening equipment and $7,639 for the pulverizing equipment, with depreciation periods of ten and fifteen years respectively, and a total fixed and operating cost of $14.39 per day for screening and $9.59 for pulverizing. These costs are estimated on four months' actual operation of the machinery and assume continuous 24-hour operation for 365 days in the year, with an average daily output of 93.8 tons of finished product.

Both the screens and the disintegrators were made by the Stedman's Foundry & Machine Works, Aurora, Ind. The operation of the sewage-works and the fertilizer plant is under the direction of Robert Cramer, chief engineer of the Milwaukee Sewerage Commission.

Some Recent Points Decided in Engineering Law

REVIEWED BY HERBERT BRAASCH
Attorney at Law, New York City

DECISIONS reached in cases tried in the higher federal courts and in the state supreme courts are summarized in these articles appearing from time to time in *Engineering News-Record*. The last group will be found in the issue of Aug. 15, 1929, p. 263.—EDITOR.

Value of Misappropriated Sand and Gravel

The owner of land containing sand and gravel deposits brought an action against the Arkansas Power & Light Company for the value of 300,000 cu.yd. of sand and gravel removed from her land and used in the construction of a dam. Though ownership and a taking were established, the damages to be allowed were in dispute. The power company contended damages were confined to the value of such material in the ground before the deposit was worked or the gravel severed. The owner of the deposit claimed $1.25 per cubic yard, the value of the material washed and screened.

It was held that a trespasser removing gravel under a belief that he had a right to do so (as a belief that he was the owner or that he had permission from the owner) is liable for the value of the gravel in the ground. If the act is one of willful trespass, damages are the value of the gravel severed from the land and such wrong-doer cannot be allowed his expense in severing and removing the material.—*Arkansas Power & Light Company vs. Decker, Arkansas.*

Zoning Ordinance Revokes Building Permit

Dawley received a permit June 13, 1927, for the construction of a business structure in the city of Lansing. Then a valid zoning ordinance was passed including the property in a residential area, the ordinance becoming effective July 24, 1927. Between these dates Dawley commissioned architects to prepare plans and also made a survey of the premises but made no tangible change in the land by exvacation or construction. On Aug. 10 the city returned the license fee and advised Dawley that his permit was revoked. After this date actual operations were under way. There followed a suit by the city to restrain construction, in which the owner as justification showed he had made substantial time and money expenditures relying on the old ordinance and had thus created a property right.

The court distinguished between money spent for plans, surveys and financing and tangible operations on the site, denying any property came into existence in the former but admitting such right did exist where there was any substantial expenditure in excavation, erection or other site operation. Construction had proceeded to the placement of footings when the city actually had work stopped. The builder claimed that though the permit had been revoked, the city had permitted work to proceed to substantial proportions and because of this had lost its right to prevent the builder from proceeding. The city met this contention by showing it could not know the builder was not erecting apartments or residential buildings until footings were put in. Only then was the city sure that stores were being included in the building.—*City of Lansing vs. Dawley, Michigan.*

Fees for Professional Services on Abandoned Work

Weisberg, an engineer, made an agreement to furnish plans and specifications, supervise installation of equipment and instruct in preparation of materials and in maintenance of a metal-plating plant. He was to receive $1,000 for this service, $300 when his services were retained and $700 when the completed plant was turned over in commercial production. The $300 was paid, plans were made and equipment as specified was ordered by the owner and delivered. The owner made several delays in undertaking further work and about three months later informed the engineer that the job was temporarily discontinued. Weisberg then claimed the $700 as a balance due, contending the unreasonable delay entitled him to payment, being equivalent to complete performance on his part.

The court distinguished the case from a wrongful discharge from ordinary full-time and exclusive employment where damages are reduced by earnings received after other employment is obtained. Distinction also was made between professional services and a contractor whose claim is reduced by the value of materials and labor saved by a discontinuance of work. The contract of the engineer was for professional service and advice and he is saved nothing if such service is not utilized. He is entitled to the entire agreed price.—*Weisberg vs. Art Work Shop, New York (Appellate Division).*

Street Obstructions

Paving contractors, the W. C. Mullins Company, were carrying out street work under contract with Kansas City. Crushed stone for a job just starting was dumped in a street, forming a pile about 3 ft. high. This was the only obstruction placed in the street; there was room left for vehicles to pass. No light was placed on the pile, which had remained there only a day or two. A motorist driving at night overturned and suffered injury when he drove into the obstruction. The contractor, admitting improperly warning of the condition of the road, claimed the motorist had also been negligent. There was room to pass around the crushed rock, the lights of the car should have revealed its presence, and good brakes could have stopped the car.

Negligence of an injured party (though this contributing negligence is much less than the negligence or carelessness of the other party) bars all money recovery. The theory is that he who asks such damages must himself be free from fault. The motorist testified that the obstruction was of the same color as the road, and though he was observant at the time, he failed to see it. The jury, finding the motorist had not been negligent, awarded damages for the injury and the court upheld this finding.—*Plater vs. W. C. Mullins Construction Company, Missouri.*

Stabilization Methods Used on the Indus Recommended for the Mississippi

Formation of Still-Water Pockets as Used to Control the Indus River Believed to Be Applicable to the Mississippi—Plum Point Reach Taken as an Example of What Might Be Done on the Mississippi River

By P. Claxton

Executive Engineer, Indus Canals Division, Dera Ghazi Kahn, Punjab, India

About a Year Ago *Engineering News-Record* published an article in which Ramey Williams, a man of long experience in navigating the Mississpipi River, described the fruitlessness of the sporadic attempts to stabilize Plum Point Reach on the Mississippi River during a period of 47 years by the use of spur dikes and training walls. While these attempts had suffered seriously from insufficiency of funds supplied, their failure was so thoroughgoing as to suggest entire inadequacy of the method. In the article which follows, P. Claxton, an engineer experienced in similar work on the Indus River, discusses the case in the light of experience on that stream. He suggests that a method used there might prove successful here.

—Editor.

That the meanderings of alluvial rivers are governed by a fixed law was shown by the writer in an article published in *Engineering News-Record* of Aug. 18, 1927, p. 268; and how such meanderings may be controlled by the formation of still-water pockets was further shown in a second article published Nov. 3, 1927, p. 720. The conclusions of the first article in so far as they apply to the Mississippi River are supported by the conclusions found in an article by Ramey Williams on the stabilization of the Plum Point Reach published in the issue of Nov. 29, 1928, p. 801. Analysis of this latter article also leads to the deduction of a definite principle of river control based on the writer's second article.

A map of a section of the Plum Point Reach which was reproduced in Mr. Williams' article is here reproduced as Fig. 1. In it the thread of the stream as of 1904 and that of 1927 are shown. The changes stand out as loops which have changed places on either side of the stream. Control works, by spur dikes for contraction, and revetment were carried out, but abandoned, and the changes represent the result of developments over some 47 years. The conclusions reached by Mr. Williams support the popular surmise that "the Mississippi is not the kind of river that you can boss around and make stay where you put it." Either that, or "the principles of stabilization do not rest on a sufficiently adequate knowledge of the underlying facts to make them dependable."

Starting from here, the writer would like to review Mr. Williams' findings in the light of his experience on the Indus River in India. The Mississippi is naturally a more stable river than the Indus, on which the writer has served a good many years. If it were as unstable as the Indus, stabilization, as undertaken there, would be a dream, as it is here. But because the Indus is so unstable it may have shown us that which the Mississippi has missed. Undoubtedly the two rivers, being alluvial,

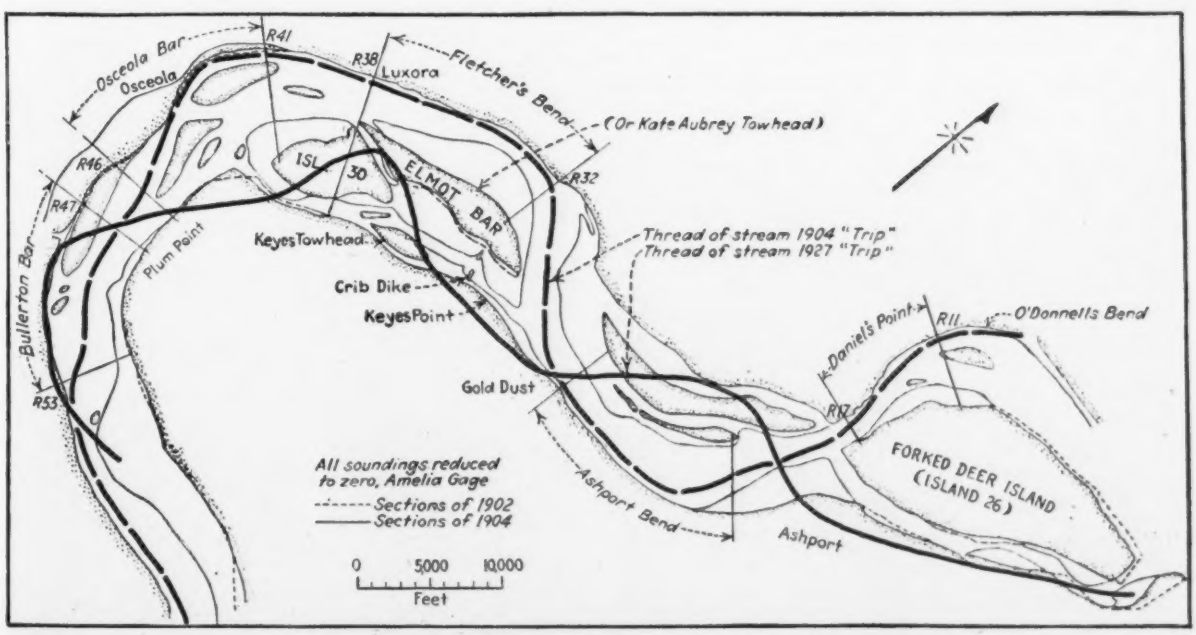


FIG. 1—PLUM POINT REACH ON THE MISSISSIPPI RIVER

Condition of the river in 1904 shown, together with the thread of the river as of 1927; the latter shown as a solid line.

obey the same laws, but one is more sensitive than the other, and what the Mississippi has done at Plum Point in 47 years the Indus can do in 3. The principles on which it works are therefore more arresting, and the methods of control must be more effective. The writer therefore begs no credit but offers no apologies for his remarks.

The meanderings of an alluvial river were shown in the writer's first article to be due mainly to erosion of banks. The silt eroded along the face of one bank increases with the length of eroded bank until it becomes a strong turning factor. Silt eroded from a bank on one side is not carried to the other side, but reappears as a shoal below the erosion which is capable of turning the stream.

The changes at Plum Point bear out the truth of this. The thread of the stream of 1927 stands in opposite contrast to the thread of the stream of 1904. Why? Some strong turning force must have been at work to force it into these positions, and this force, the writer wishes to show, is *silt*. Beginning at the chute to the left of Forked Deer Island (No. 26), what led the river to head to the west *across* the thread line of 1904? The easier course would have been to follow the more direct Ashport Bend which the deep stream already occupied. Instead of this it showed enormous energy not only in pushing across the ready-made direct line of flow but in excavating a new channel for itself across existing sandbars. Some strong force was pushing it west, and that force could only be the silt torn from the Ashport banks. This silt, as has been shown in the article on river meanderings, cannot be carried across to the right, but must remain on the left side, and if the shoals of 1927 were shown, one would show just below Ashport to be choking the deep stream of Ashport bend of 1904.

Again, when the river had reached the right bank on the opposite side, why should it not have continued along the chute existing on that side into Fletcher's Bend? Here also a strong turning force, as a shoal, the result of erosion of shoal and bank on the right side, is in evidence.

This is all the more striking, for after reaching the old deep stream of 1904 at Gold Dust the thread line does not flow into its old ready-made channel, but pushes across and works into bank and shoal on the left, which it could never do were not a strong force driving it. That force is silt, torn on the right side from shoals above.

Having worked into Keyes Point and reached close to Keyes Towhead, it struggles across the existing chute into the Elmot Bar. Unable to break through here, after a great effort it loops back on itself, again crosses the Keyes Towhead Chute, and passes on to attack Plum Point. From here it is carried across the old stream till it impinges on Bullerton Bar.

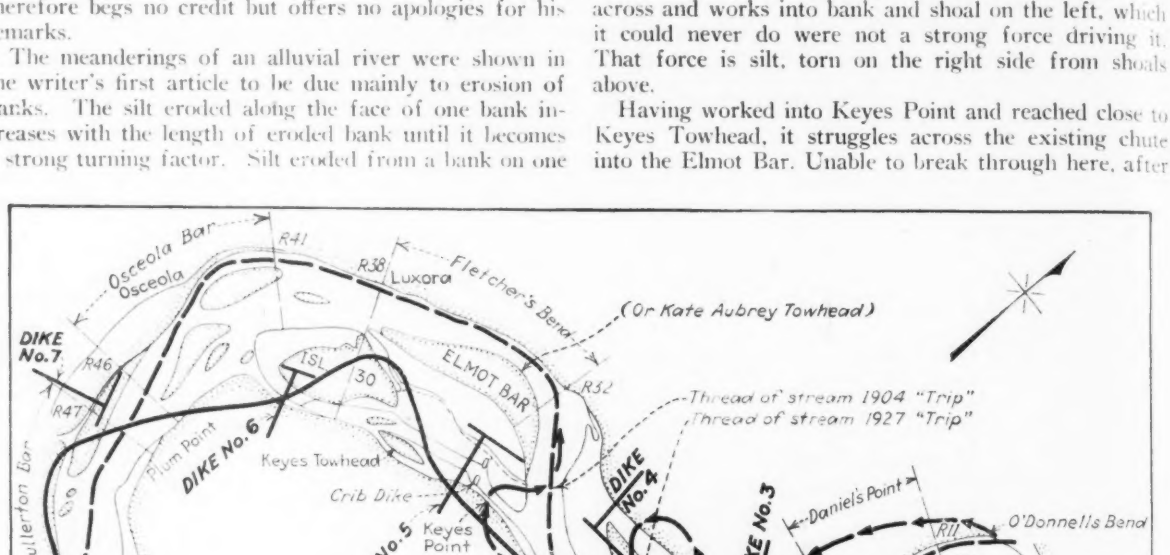


FIG. 2.—STILL-WATER POCKET USED TO CONTROL PLUM POINT REACH
Possible location of dikes to form still-water pocket shown on map given in Fig. 1.

All this evidence leaves not a shadow of doubt that the stream would not behave so contrary to laws of flow drawing it into natural and easy beds unless it were driven by a force stronger than these laws. This force, as the writer has tried to show, is no other than *silt*. The stream spends its energy by attacking a bank or shoal, and in turn this reacts in turning the stream. Thus action and reaction play out their role and let the stream down by stages to the sea.

Now, bank revetment partly stops erosion and tends to eliminate the force by which streams are turned and meander, but revetment cannot stop *all* erosion, for erosion will attack shoals as well as banks, and shoals cannot be protected. Changes in the stream are therefore still inherent and sooner or later make themselves felt, as at Plum Point. Moreover, revetment is very expensive, and because of expense cannot be given as full effect even at the banks as it should be. For this reason we need to turn elsewhere to find if possible a more effective and cheaper remedy. The writer is of the opinion that one lies close at hand in the modification of the Bell's bund system or the still-water pocket principle enunciated in his second article.

It was there shown that points on the river can be brought under complete control by the formation of still-water pockets. These pockets need only stone protection at their head and the exposed river side, the rest being made of earth. They are therefore cheap, but it is to be shown whether they will also be effective.

On the Plum Point Reach in Fig. 2 the writer has shown how the still-water pocket system may be applied. He cannot say whether a flood levee exists some distance back from the river's edge. If it does exist, far enough from the edge to be safe against erosion, the trunk of each dike shown by him would be joined to the levee. But if it does not exist, the trunk will simply be carried far enough inland to be safe. River spill may pass around the farther end of the trunk, but erosion, or the cutting action of the river, which alone is dangerous, cannot reach it, as will be shown later.

Six points of control have been chosen at which dikes will be built. Why these points of control have been chosen will become clear subsequently. They hold the offtakes and outfalls of the side chutes or creeks. These chutes have been the main stream once, but have diminished because of silt movements. With other movements they may again become the main stream. Their sectional capacity is often very large and offers facilities for such changes. When therefore we close the offtake we choke off the chances which exist here by which the main stream may again be drawn into the head of the chute. And when we close the outfall we block the chances by which channels which wander into the chute below the head may develop. Indeed, it is the outfall which is more dangerous, for after the head has silted up the outfall remains a deep back-water from which changes readily work upward by retrogression of bed levels. To close these sources of danger will not be difficult, for the main stream is not in question. When the river is low each side chute grows small, and may be further choked by temporary brushwood and stake dikes. The head may then be closed and the permanent dikes completed.

In doing so the still-water pocket is created by a long arm running upstream from the end of the dike. Another short arm runs downstream, but this is only for back-water attack. The two arms together form a T-head which must be heavily protected with stone revetment at the two ends and along the river face. An apron of stone must also be laid along the toe and spread over the bed to secure the head against longitudinal scour. All these points belong to the Bell's bund system of protection, but are merely briefly recapitulated here to recall them.

Having closed the points of danger on the side chutes, erosion by the main stream around the bends may continue, but is now actually under control and is limited. Suppose that it grows intense at Daniel's Point and ultimately reaches a line shown by the arrowheads. By doing so it works into the pocket of dike No. 3 and loops back, as it must, on itself, till eventually a short circuit forms along the chord and the stream returns to its old position. To accomplish this the pocket which is formed by the long arm of the T must be long enough to force the loop into its critical position at which short circuiting across the chord occurs before the outer bend of the loop reaches the trunk of the dike. By this pocket and heavy revetment of the T-head, the dike is impregnable. So are all the dikes impregnable. The river is therefore held between every pair of dikes, one near the outfall and the other near the offtake of opposite chutes. Not only, therefore, is the danger in development of the side chutes eliminated but the main stream itself is brought under control.

Under these conditions the river is allowed to erode (if it were not, its régime would be seriously affected), but erosion around the bends along the banks is limited and controlled. By a process of alternate looping up and short circuiting erosion becomes a harmless operation so far as stability is concerned.

This applies to attack from above, but suppose the main stream breaks into a side chute below a dike. For instance, the loop at Daniel's Point, in growing critical, may swing to the opposite side and eat into shoals, the silt from which reacts and forces it again to the right *below* dike No. 3. We have already provided against this possibility by constructing dike No. 4, and this prevents the development of the chute from the outfall. Balked in its attempt, the stream may swing to the left, but is met by dike No. 5 and is led into Fletcher's Bend, its old course. These acute meanderings can only be short lived, for by short circuiting they work the main stream back to its old position. Bound on the land and river sides, it has to follow one course, that laid down originally by itself. Its régime and freedom have not been assailed, but it has simply been asked to stay where it put itself.

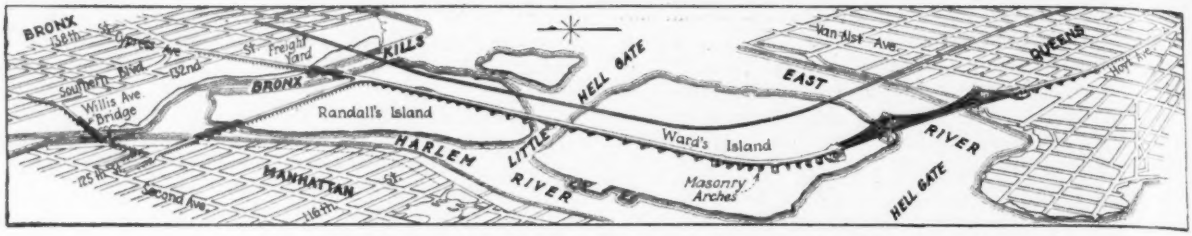
These works by keeping the main stream to one channel bring about contraction, but omit revetment. In cost they should therefore be less than works which aim both at contraction and revetment. They have also now, the writer hopes, been shown to be more permanent.

The writer is on the opposite side of the world to that in which the Mississippi flows, and he cannot have all the conditions accurately before him. Yet he has another river, the Indus, more restless than the Mississippi, and the principles which he deduces from it he thinks are essentially correct. He only asks that his conclusions be judged by the principles, and is of opinion that details where wrong can be made to fit them.

The rivers make their bow to each other and hope for better acquaintance, so that they may be able to appreciate each other's views to each other's mutual advantage.

Salt Water Advances up San Francisco Bay

Suisun Bay, an arm of San Francisco Bay, extends inland to the outlet of the Sacramento and San Joaquin rivers. Although tidal effects have been noted up the Sacramento River as far as the city of that name, more than 100 miles from the Golden Gate, salt water was formerly kept out of the Suisun Bay and the delta region by the fresh-water flow from the tributary streams. In recent years, however, more and more of the flow of the two rivers has been diverted in upper reaches of the streams for irrigation, and the salinity in Suisun Bay has steadily increased. With this inland advance of the salt water has come tainting of the water pumped from wells for domestic and irrigation purposes in the delta region. Twenty-five years ago, when the California-Hawaiian Sugar Company built its refinery at Crockett, on the lower end of Suisun Bay about 30 miles from the Golden Gate, waters of the bay at Crockett were fresh enough for use in the plant most of the year. Now salt water is found at double this distance up the bay from the Golden Gate and the sugar company is building a pipe line to bring in a 2,500,000 gal. daily water supply from wells 16 miles away.



FIRST STAGE OF DEVELOPMENT, TRIBOROUGH BRIDGE
Second deck to be added in future when traffic volume justifies.

New York Plans Vehicular Bridge Across East River at Hell Gate

Streets of Three Divisions of New York City to Be Joined by Structure Including 1,380-Ft. Suspension Span—Foundation Work to Start Soon

TRAFFIC between sections of New York City divided by the East River, hitherto carried by four major bridges across that stream, has increased so rapidly during the past few years that some additional crossing is imperative, especially in view of the approaching completion of the Hudson River bridge, which will bring many vehicles into the upper part of Manhattan bound for destinations on Long Island. To relieve the situation, it is proposed to construct a river crossing to consist of four large bridges across the navigable waters connected by viaducts on Ward's and Randall's islands, together with suitable approaches in the boroughs of Manhattan, the Bronx and Queens. This structure, known as the Triborough bridge, was first suggested as long ago as 1916 in the annual report of Edward A. Byrne, chief engineer of the city Department of Plant and Structures.

Details of the Project

Of the total length of 17,710 ft. in the crossing, 4,318 ft. will consist of bridge structures, the remainder of viaduct and masonry approaches. The most important part of the project will be a suspension bridge over Hell Gate in the East River which will have a clear span of 1,380 ft. with two approach spans each 670 ft. long. Clearance will be 135 ft. above mean high water, the same as the four bridges downstream. The crossing over Little Hell Gate, between the two islands, will be made by two 375-ft. steel arches with a clearance of not less than 50 ft. for 180 ft. in each span. Bronx Kills, a comparatively unimportant stream, will be crossed by a fixed bridge 268 ft. long with a 50-ft. clearance, provision being made for future conversion of the main span to the bascule type when necessary. The remaining bridge, over the Harlem River at 125th St., Manhattan, will consist of a 320-ft. vertical lift span with side approaches. Clearances will be 55 and 135 ft. in closed and open positions.

Throughout the 13,560-ft. length of the main structure, as differentiated from the Manhattan approach, there will be two 40-ft. roadways and two walkways each 7 ft. 7 in. wide, with the exception of the main suspension span over the East River, which will have two 36-ft. roadways and a single footwalk 10 ft. wide. No provision is made for rapid-transit lines. In the expectation that traffic will increase greatly in the future, all foundations, the towers, anchorages and cables of the suspension span and the viaduct columns will be designed to support a second deck without further strengthening. The Manhattan connection from Second Ave. and 125th St. to the main bridge will be 4,150 ft. in length and will provide for six lines of traffic.

Approaches—In determining the location of the structure special attention was paid to the problem of suitable connections with the main street systems in the respective boroughs. At each of the terminals private property will be acquired to provide suitable plazas and approaches and in each case the bridge traffic will be delivered to existing main traffic arteries. Negotiations for the acquisition of the necessary private property, which is assessed at a valuation of $3,606,600, are now under way.

Grades—Throughout the main portion of the structure the roadway is practically level, but it has been necessary to increase the gradient at the various approaches. The maximum grade of 3.78 per cent occurs on 237 ft. of the Bronx approach, and is immediately adjacent to a 695-ft. length of 2 per cent grade. At the Manhattan approach a grade of 3.6 per cent for 1,300 ft. is necessary to attain a proper elevation for the Harlem River crossing. In Queens the 3,218-ft. approach to the main suspension span has a grade of 3.26 per cent.

Cost—Besides the amount necessary to acquire private property, the preliminary estimate of cost includes the following items: main structure, including Manhattan connection, $22,000,000; engineering and contingencies, $1,500,000; removal of buildings on the islands, $1,125,000; a total of $24,625,000 exclusive of property cost. Although these figures are based upon plans drawn up in 1927, which have been changed materially since that time, it is believed that the final cost of construction will not vary more than 5 per cent from the estimate, even though the bridge has been lengthened 860 ft. The increased length results from a change in alignment made at the request of the state to avoid interference with buildings on Ward's Island. Despite the change, it will be necessary to move eleven buildings on Randall's Island, some of which were built as long ago as 1847.

Foundation Conditions Favorable

Preliminary borings already made indicate that satisfactory rock will be found throughout practically the entire length of the structure just below the surface. To avoid the delay incident to further exploration, the first foundation contracts, to be let Oct. 22, provide for additional

diamond drill holes, and contain a provision that any concrete piling which may be found necessary will be installed by the contractor at a stated price of $3 per linear foot. By setting a definite price for this contingency the city expects to eliminate unbalanced bidding. The first contracts are to include the construction of 23 pier foundations on the two islands and the two main towers for the suspension bridge, involving about 60,000 cu.yd. of earth and rock excavation and 54,000 cu.yd. of concrete. Other contracts will be awarded when the necessary property has been acquired.

The Triborough bridge has been officially declared a revenue-producing structure by the city of New York, and will be financed by the issue of corporate stock of the city, to be redeemed by the revenue resulting from toll charges. The plans have been approved by the city authorities, and all crossings of navigable streams have been designed in accordance with the requirements of the Corps of Engineers. Permission to cross Ward's Island has been granted by the legislature of the State of New York, and an appropriation of $3,000,000 has been authorized by the city for the first stage of construction. The Triborough bridge is to be built by the Department of Plant and Structures of the city of New York, Albert Goldman, commissioner; Edward A. Byrne, chief engineer.

Operation of the Sewage-Works at Indianapolis, Ind.

SPIRAL flow in aerators for sewage treatment was applied for the first time in this country at the Indianapolis sewage-works, which were designed after about two years of testing-station experiments, which ended in November, 1922. The clarification plant, with a capacity of 120,000,000 gal. daily, went into service in June, 1924, and the activated-sludge plant, (capacity 35,000,000 gal. daily) in May, 1925. A combination of fine screens and rapid sedimentation is used in the clarification system; the screens, acting as concentrators, take away about 66 per cent of the volume of sewage flow, leaving the solids rejected by the screens in one-third of the sewage, which is passed into settlers having a detention period of a little less than twenty minutes. This treatment results in the removal of approximately 40 per cent of the total suspended solids. The sewage is skimmed at the grit chambers, at the entrance to the clarification plant and again in the rapid settlers.

Aeration to separate grease is arranged at the entrance to the clarification plant, the aerators being designed for spiral flow by placing tile on one side of the tanks only. The settling basins have sloping bottoms and the sludge is prevented from sticking to the sides by revolving arms carrying chains which drag the bottom. Each basin has an influent from opposite sides, the two currents tending to neutralize each other. The effluent weirs are placed at three points across the basin in order to avoid short circuiting. Sludge from the clarification plant and waste activated sludge are pumped together to deep digestion pits, where biological action and natural drainage produce in a few months a well-digested sludge of about 85 per cent moisture. This material is taken by market gardeners and by farmers, some 17,000 cu.yd. being used in this way in 1928. The works as then proposed were described in *Engineering News-Record*, March 23, 1922, p. 484, and Aug. 16, 1923, p. 258, and the sludge digestion system in the issue of Feb. 9, 1928, p. 230. They were designed by Charles H. Hurd, consulting engineer, Indianapolis, and are operated under his supervision as engineer for the Sanitary District of Indianapolis.

Marine Divers "Service" Piling at Cost of 50c. Per Pile

ABOUT 2,000 creosoted wood piles which have been in service on the Seattle waterfront for fourteen years were recently given a thorough examination by marine divers, who not only reported in detail on the condition of each pile but rendered material service in prolonging the life of the piles by destroying borers. The work done might well be classed as servicing the piles.

A firm of marine divers experienced in pile inspection was engaged to examine the piles, which stand in water depths ranging up to 50 ft. Two divers worked together, operating from a single unit in a boat moored at the face of the wharf. Only one diver was under water at one time, but by operating with two divers the crew could work continuously while the light was good, which was usually only six to seven hours a day during the summer months. Divers worked out one row of piles and back on the next. Usually the divers changed shifts so that each one spent half of the working day under water.

The diver would make several trips up and down each pile between mud line and water surface, examining all sides and reporting by telephone constantly to the note keeper in the boat. One word indicated the rating of each pile. The ratings were: "perfect," "good," "fair," "bad," and were defined as follows:

"Perfect"—A pile showing no sign of attack by borers.

"Good"—A pile whose ability to carry its load is unimpaired but whose creosoted protection has been penetrated at a few places by borers.

"Fair"—A pile still able to carry its load but not to be depended upon for more than a very few years.

"Bad"—A pile so badly attacked as to be of little or no value from a load-carrying standpoint.

The marine borer that causes the most serious destruction in creosoted piles along the Seattle waterfront is *Bankia setacea*. The piles are attacked through knot holes and wherever damaged surfaces or other vulnerable spots afford entrance points through the creosoting. This borer leaves a portion of its body continuously projecting from the entrance to its tunnel for the purpose of siphoning in food. Whenever *Bankia* were found the diver would strike the projecting portion with a hammer, and it is believed that in this way most of the destructive boring of the piles, for a time at least, was brought to a standstill.

Of the 2,000 piles examined after a period of fourteen years of service, the rating was as follows: 77 per cent perfect, 17 per cent good, 2 per cent fair, 4 per cent bad. Of those rated as "bad," a number were replaced soon after the inspection, when renewal of the deck structure afforded an opportunity.

Inspection by divers is not novel at Seattle, inasmuch as the Northern Pacific Railroad frequently has made previous use of this method. In fact, it was because of experience on structures owned by that railroad that divers were found who had intimate knowledge of the methods that would be effective.

The work was done under the direction of J. R. West, port engineer, Port of Seattle.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Data on Building Construction

REVIEWED BY ROBERT W. BOYD

Engineer, Turner Construction Company, New York City

HANDBOOK OF BUILDING CONSTRUCTION: Data for Architects, Designing and Construction Engineers and Contractors. Vols. I and II—Compiled by a staff of 50 specialists. Editors-in-Chief: George A. Hool, S.B., Consulting Engineer, Madison, Wis., Professor of Structural Engineering, University of Wisconsin, and Nathan C. Johnson, M.M.E., Consulting Engineer, New York City. New York: McGraw-Hill Book Co. Second Edition. Bound: 6x9 in.: pp. 1611 in both volumes: many illustrations. $10.

Architects, engineers and others connected with the building industry will be glad to know that this comprehensive and useful compilation of building construction data is to be kept abreast of developments in theory and practice. Since the appearance of the first edition, in 1920, the book has held an enviable place among handbooks of its kind. The present revision assures a continuance of that position.

The roll of associate editors has been increased from 46 to 50. Nine new names appear, while five of the old ones drop out. The general form and arrangement of the book are unchanged and with the exception of the table of contents and the index, there has been practically no change in the typography. In some cases matter considered by the editors of secondary importance has been relegated to small type, apparently to save space. The rewriting of a number of sections and the new material included have added about 150 pp.

One of the criticisms of the first edition was that the book contained matter which might well be included in an exhaustive treatise but was out of place in a handbook designed for ready reference. This defect has not been remedied. The space devoted to such items as cast-iron lintels could be saved and various discussions of matters quite elemental and obvious could be deleted with trifling loss.

The sections which have been rewritten and the material which has been added have been generally in the line of improvement. Those interested in concrete design and construction will welcome the appearance of Arthur R. Lord as one of the associate editors. His articles on concrete columns and flat slab construction are particularly noteworthy. The article on structural clay tile has been brought up to date and much improved by H. Ray Kingsley. The discussion of stucco by W. E. Hart is entirely new, and the data on terra cotta have been largely rewritten by the original author, D. Knickerbacker Boyd. The articles on footings, piledriving, earth-excavation equipment and concrete equipment have been rewritten and improved. An entirely new article by A. W. Piltz on metal lumber has been added. It describes the various types of light-load bearing-floor construction in which light steel members are employed. The data on elevators have been entirely revised. The description of types no longer used is omitted and the whole subject has been brought up to date in line with the rapid development in elevator design and construction. Daniel I. Hauer has practically rewritten the article on contracts. Its value is greatly increased.

Some changes have been made in the index, but there is still room for improvement. Placing a complete index at the end of each volume is a distinct advance, but there are many valubale data such as the Wellington or *Engineering News* formula for piledriving buried in the text, with no mention either in the table of contents or the index. There are indications that the proofreading of the new edition has not been all that it should be. An important heading on foundations has been omitted in the table of contents and on p. 1123 there is mention of an industrial building project which if actually of the size reported would have had publicity comparable with the German debt.

Russia's Five-Year Construction Plan

THE SOVIET UNION LOOKS AHEAD: The Five-Year Plan for Economic Construction. New York: Horace Liveright. Cloth; 5x8 in.; pp. 275; line cuts and tables. $2.50.

Whatever may be thought of the plan or the ways and means proposed for its execution, Russia deserves credit for being the first nation in the world to work out a complete program of industrial and economic development designed to meet the needs of all its people. This it has done by means of the State-Planning Commission (Gosplan) of the U.S.S.R. The commission's plan and the benefits which it is believed will accompany its execution are tersely, clearly and interestingly set forth in the book before us. Only courage born of conviction could have conceived such a comprehensive five-year plan for the economic construction of Russia and nothing short of a well-organized agency could ever have gathered the necessary data and condensed them into such well-ordered form that the essentials of the program can be grasped in an hour or two of not at all difficult reading.

After a general summary of the economic condition of Russia, the planning commission presents its five-year development program, involving a total capital outlay of 64.6 million rubles, or about half as many dollars, under ten heads: electric power, fuel, metals, machine construction, chemical industries, building materials, forestry and lumber, industry as a whole, agriculture, transportation, housing. Next, the problem of providing skilled labor in the various fields, including engineers and technicians, is considered. Seventeen pages are devoted to volume of production and the productivity of national labor. Attention is then given the labor problem in general, including number of wage earners, wages, length of working day and insurance. The comprehensiveness of the study is illustrated by a chapter on equilibrium of supply and demand, consumption and price policy. These follow chapters on Russia's financial and social problems and foreign trade. Tabular data, more detailed than the summaries in the body of the book, are given in appendixes. Finally, of no little interest in America, is a List of Technical Assistance Agreements, comprising the names of 25 engineers, engineering and manufacturing companies with whom relations have been established in the last two years. Most if not all of these are American.

The list just mentioned and a preceding list of American manufacturing concerns that have given five-

year credits to the Soviet Union, and the high percentage of Russia's import and export trade that goes to America, combined with the enormous construction and new-equipment program included in the five-year plan, are in themselves enough to recommend for this book wide reading and careful study in this country. Beyond these reasons, based on desire for professional work or for trade, the book should have a strong appeal everywhere as a political and human document unparalleled in the annals of nations.

Wells and Well Pumps

REVIEWED BY H. L. WHITE
Assistant Engineer,
Illinois State Water Survey Division, Urbana, Ill.

ROHR BRUNNEN—Von Dr.-Ing. Erich Bieske, Direktor Der E. Bieske Aktiengesellschaft, Königsberg I. Pr. München: R. Oldenbourg. Cloth; 6¼x9¼ in.; pp. 214; 170 illustrations. 14 marks.

Persons who have any connection with well construction or maintenance should be interested in this book. It discusses briefly all phases of work involved during the various stages of a well's life. Enough description is given to enable persons not familiar with the subject to understand the problems and the solutions. The experienced person will find suggestions which will aid him in solving special difficulties.

The author mentions factors which affect the underground flow of water and gives formulas for the relation between drawdown and yield of wells. Various types of wells and well pumps are discussed briefly. The author mentions a centrifugal pump with a special device that is used in place of a deep-well pump for small quantities and for lifts higher than the usual suction lifts. The pump used had a discharge of 13 gal. per minute with a suction lift of 79 ft. The device is not described, but it appears in an illustration that an ejector is placed on the suction pipe.

Sixty different types of well screens are mentioned. These are made of metal, wood and stone. A gravel-packed screen made for use in fine sand has a series of conical bowls attached to it to hold the graded gravel. The screen and gravel packing are lowered into the well as a unit. A method of keeping drilling records is explained, and a few pages from a log book are shown. Costs of casings, screen, drilling and other work encountered in well construction are given.

One Hundred Years of the B. & O.

THE STORY OF THE BALTIMORE & OHIO RAILROAD—1827-1927—Vols. I and II—By Edward Hungerford, New York: G. P. Putnam's Sons. London: The Knickerbocker Press. Cloth; 6¼x9¼ in.; pp. 372 in Vol. I; pp. 365 in Vol. II; both volumes profusely illustrated. $10.

Few historians have been so saturated in their subject when they began to write as was Edward Hungerford when he began to formulate this history of the Baltimore & Ohio Railroad. About three years ago, when the Baltimore & Ohio Railroad Company decided to celebrate its centennial by an elaborate historical pageant, Mr. Hungerford was engaged to take a major part in that work. Much stress was laid by the company upon its desire for accuracy in the details of the events to be portrayed, and as a result Mr. Hungerford's search for data to give correct background and color led him far afield into the contemporary history of the days when the Baltimore & Ohio Railroad was first organized. The present volumes are the natural outgrowth of that experience. Much that was learned by Mr. Hungerford and his coworkers went into the unsurpassed spectacle of early railroad history which was staged at Baltimore during the fall of 1927, but much more could not be portrayed in that way; it needed to be set down in the written word.

That the written record is well worth reading hardly need be said. Given an author of Mr. Hungerford's ability and a subject as absorbing as the early history of a great railroad, and the result is obvious. Quite naturally, such a record could not be confined to the railroad itself. It goes far afield into the contemporary history which was unearthed, especially that of the early days of the railroad, in order to explain the antecedents of events materially affecting the railroad. This is especially true in the description of the relation of highways and canals to the transportation needs of this country in the early years of the nineteenth century.

Specifically, the first volume carries the railroad through the development period and up to the opening of the Civil War. The second volume takes it through the exciting days of the Civil War, through the period of great expansion and that of financial difficulties, and the overlordship of the Pennsylvania Railroad which followed, through the improvements of the turn of the century, and finally through the World War and the period of government control. Personalities have impressed themselves upon the record of the Baltimore & Ohio, as in the case of most of our great railroads, and consequently no little space is devoted to the fourteen men who have served as its presidents, from Philip E. Thomas to the man who now directs its destinies, Daniel Willard.

Russian Work on Highway Engineering

REVIEWED BY S. A. VASSILIEV
Professor of Highway Engineering in Odessa,
Member Russian Hydrological Institute

TEXTBOOK ON HIGHWAY ENGINEERING [Printed in Russian]—By D. P. Krynine, Professor of Highway Engineering, Moscow Superior Technical School and Moscow Institute of Transportation Engineering. Second Edition. Moscow: U.S.S.R. Cloth; 7½x10½ in.; pp. 923; 736 illustrations. 10 rubles ($5).

The second edition of Prof. Krynine's Highway Engineering is an outstanding accomplishment. One could predict for it a very wide circulation were it written in English or German. With its 923 pages and 736 illustrations, the book seems to be a most thorough and complete work on highway engineering principles and practice. Primarily, it was intended as a textbook for advanced students, but it is valuable also as a reference book on general design and administration. Although the author could not include in one volume a complete treatment of each topic, his large volume is a practical handbook for all of the technical details and processes of highway construction and maintenance work.

The book combines the scientific and the practical. The former is represented by a thorough exposition of soil physics and soil mechanics, as applied in highway engineering. Some of Professor Krynine's ideas concerning the application of physics and the theory of elasticity are given in his discussion of Dr. Ch. Terzaghi's report on the Science of Foundations. Colloid chemistry is taken up in an appendix.

Under highway practice the author begins with low-cost roads, discussing the construction and maintenance of earth, sand-clay and gravel roads. These chapters

were written under the influence of American practice as to machinery, contractor's plant and work methods. In the discussion of other types European practice is considered as well; as also in the chapter on the application of "organic binders" (tars, bitumens, asphalts). In this chapter the author was assisted by Prof. P. V. Sakharoff.

The construction of concrete roads is thoroughly described and numerous examples of machinery, as well as different methods of joint arrangement, are given. Attention is paid to German methods of concrete road construction, which have been highly developed in recent years.

Much space is devoted to the "mechanics of metaling" as the author calls it. In this chapter the nature of external and internal forces acting on and in the road are discussed. Westergard's theories are cited. The author terminates his work with a consideration of highway economics, administration and finance and a brief review of road engineering during the war. It is regrettable that the book is provided with a subject index only, an author index being omitted.

At the present moment, when America is interested in exporting motor cars and road-constructing machinery to Russia, Professor Krynine's book, written in the language of that country, has a special interest for American business circles.

Airplane Engines

MODERN AVIATION ENGINES: Design, Construction, Operation and Repair—By Major Victor W. Pagé, U. S. Air Corps Reserves, M. Soc. Automobile Eng. Two volumes. New York: Norman W. Henley Pub. Co. Cloth; 6x9¼ in.; pp. 1908 in both volumes, with 919 line cuts and halftones. $5 a volume; $9 for both.

Primarily these two volumes comprise a service manual for the guidance of those engaged in the repair of airplane engines. As such, they are amazing in their thoroughness, containing detailed descriptions of all the well-known motors, both domestic and foreign, in minute detail. To readers outside this specialized field the book, particularly Vol. I, tells an amazing story of the development of a young and rapidly growing industry, beginning with the crude motor used by the Wright brothers at Kittyhawk and bringing the reader step by step to the complicated and efficient power plants used in our present-day record-breaking airplanes and dirigibles. It is doubtful if the author had this story in mind when writing, but the story is there, even more effectively told because of the casual way in which it is related. Aviation engines are, because of the unusual conditions under which they operate, the utmost refinement of power production.

How to Read Faster and With More Profit

THE ART OF RAPID READING: A Book for People Who Want to Read Faster and More Accurately—By Walter B. Pitkin, Professor in Journalism, Columbia University. New York and London: McGraw-Hill Book Co. Cloth; 6x8 in.; pp. 233; illustrated. $2.50.

Ability to read rapidly is an asset and for many a necessity today. Some are born with that ability; some have attained it; more have yet to acquire it; nearly all could increase it advantageously, even if their chief reading is for entertainment. This book on The Art of Rapid Reading should therefore have a wide field, especially as it appears to be a pioneer. Its sub-title is significant: A Book for People Who Want to Read Faster *and More Accurately* (italics ours).

The author wisely deals first with some of the causes of poor reading, such as bad posture, bad lighting of the printed page, surroundings that disturb, and untoward conditions of body and mind. He then takes up briefly what he calls improvement of "word habits" and gives a list of hundreds of words for definition, both broadly and to bring out different meanings for the same word. After providing drill in "word grasp" a chapter on improving "eye grasp" is given, then one on skimming, then still further exercises on light, average, solid and heavy reading.

It should not be thought that the book is a mere school text, for while it is well fitted for that, it appears to have been written primarily for those already launched in their life work who are, whether they know it or not, unable to keep abreast of their problems because they cannot quickly read and grasp the essential facts in the vast mass of printed material that they must or should read for even a moderate degree of success in their business or profession.

Thousands of Details of Sheet Metal Work

STANDARD PRACTICE IN SHEET METAL WORK: A Reference Book Compiled for the Use of Architects, Engineers, Sheet Metal Contractors, Installers of Warm Air Heating Systems and Vocational Training Schools—By the Trade Development Committee of the National Association of Sheet Metal Contractors of the United States. Pittsburgh: The National Association of Sheet Metal Contractors, 333 Fourth Ave. Bound; 9x19¼ in.; pp. 768; many line cuts and halftones. $10.

Thousands of details of sheet metal work used in building construction and equipment, logically assembled under various heads, are presented in this large, well-made volume. The enterprise is a notable example of the co-operative work being done today by our great trade and manufacturers' associations, work fruitful in this case for not only the members of the association but also for designers, contractors and the ultimate consumer. This volume consists mainly of handsome reproductions of skillfully and conscientiously made detail drawings, on an ample scale, well lettered for ready use. A small but sufficient amount of descriptive text is provided. The material is grouped under roofs, ceilings, heating and ventilation, doors and windows, and restaurant, kitchen and hotel equipment, with numerous subheads. There are 4 pp. of text on protective coatings and paints and 3 pp. of tables, and 24 pp. devoted to regulations of the National Board of Fire Underwriters relating to fire doors. The volume deserves a wide circulation among architects, engineers and builders.

Railway Cyclopedia Revised

RAILWAY ENGINEERING AND MAINTENANCE CYCLOPEDIA: An Authoritative Manual of Engineering, Maintenance and Signaling, Including Definitions, Descriptions, Illustrations and Methods of Use of the Materials, Equipment and Devices Employed in the Construction and Maintenance of Tracks, Bridges, Buildings, Water Service, Signals and Other Fixed Railway Properties and Facilities. Third Edition. Editor, Elmer T. Howson, Western Eidtor of *Railway Age*, Editor of *Railway Engineering and Maintenance;* Managing Editor, Walter F. Rench, Formerly Supervisor, Pennsylvania Railroad System; Associate Editor, George E. Boyd, Formerly Division Engineer, Delaware, Lackawanna & Western. Assisted by specialists; Compiled and Edited in Co-operation with the American Railway Engineering Association and the Signal Section, American Railway Association. New York: Simmons-Boardman Publishing Co. Bound; 9x12 in.; pp. 1116, with 2,500 illustrations. Cloth, $5; Leather, $7.

Although this encyclopedia is designed primarily to describe the various kinds of railroad equipment which is supplied by the manufacturers, by a careful handling of the material and supplementing it freely with data taken from the senior railway technical organizations, such as the American Railway Engineering Association,

the editors have produced a valuable manual, covering everything connected with railroad maintenance. The section devoted to definitions is particularly valuable, as it is the result of correlating the work of a number of committees of various technical organizations.

Sparrow Instead of Swallow

A confusion of names that occurred in the review of Fowler's Ideals of Engineering Architecture published in these columns on Sept. 19, is pleasantly corrected in the following note from Philip G. Laurson, associate professor of engineering mechanics, Sheffield Scientific School, Yale University:

"Accuracy in ornithology is, fortunately, not required of engineers. Nevertheless it is somewhat surprising that an engineer as well informed as Professor Spofford should attribute the Book of Bridges to Brangwyn and *Swallow*. The bird who wrote the text to accompany Brangwyn's drawings was an English sparrow. He signs his name 'W. Shaw Sparrow.'"

It seems less surprising that an engineering professor made the slip, very likely in giving the name from memory, than that it should have been noticed by another professor of engineering.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

THE CONSTRUCTION OF ROADS AND PAVEMENTS—By Thomas Radford Agg, C. E., Professor of Highway Engineering, Iowa State College, M., A.S.C.E., A.S.T.M., Soc. for Prom. of Eng. Educ. Fourth Edition. New York & London: McGraw-Hill Book Co. Cloth: 6x9 in.: pp. 511; illustrated. $4.

IOWA PUBLIC WATER SUPPLIES—Issued by Division of Sanitary Engineering, State Department of Health, Des Moines, Iowa. Engineering Bulletin No. 10. Paper: 6x9 in.: pp. 39.

Contains tabular information regarding public water supplies of the state, with summaries in the text.

THE LAW OF BUILDING CONTRACTS AND MECHANICS LIENS: What Every Owner, Contractor and Subcontractor, Engineer and Architect, Mason, Plumber, Carpenter and Materialman Should Know About It—By Myron H. Lewis, LL.B., Licensed Professional Engineer. Published by author, 507 Fifth Ave., Room 1006, New York City, or 16 Court St., Room 913, Brooklyn. Paper: 8x11 in.: pp. 98. $2.10.

Of its two parts the first is devoted largely to the law of building contracts in New York State, but the author says that most of the section is of general application. Part II is devoted to the mechanics' liens in New York State, and is supplemented by a digest of changes effective Oct. 1, 1929.

THE ROMANCE OF THE RAILS—By Agnes C. Laut. Two Volumes. New York: Robert M. McBride & Co. Cloth: 6x9 in.: pp. 589 in two volumes: illustrated. $7.50 Net.

PUBLIC CLEANSING: Collection Treatment and Utilisation of Town Refuse—By The "Jas. Jackson" Study Circle of the Birmingham Corporation Salvage Department. London: Ernest Benn. Cloth; 8x10 in.: pp. 251 and advertisements: many illustrations. 18s. net.

THE SAND AND GRAVEL RESOURCES OF NEW YORK STATE—By Charles M. Nevin, Assistant Geologist, New York State Museum. New York State Museum Bulletin. Albany: the University of the State of New York. Paper: 6x9 in.: pp. 180; 42 halftones.

STANDARD PLUMBING CODE: Sections of New York State Statutes Relating to Plumbing together with Standard Plumbing Code Recommended by the State Department of Health for Municipalities of New York State—Issued by the State Department of Health, Matthias Nicoll, Jr., M.D., Commissioner, Albany: J. B. Lyon Co. Paper: 6x9 in.: pp. 52: illustrated.

STRENGE UNTERSUCHUNGEN AM RHOMBENFACHWERK—Von, Dr.-Ing. Paul Christiani, Privadozent an der Technischen Hochschule Aachen. Berlin: Julius Springer. Paper: 6½x9½ in.: pp. 52; 17 line cuts and 18 tables. 4 reichsmarks.

STRUCTURAL MECHANICS OF THE AEROPLANE: Part I, Calculation of Continuous Spars of Wings. [Printed in Russian] —By Engineer-Professor John Podolsky. Paper; 6x9 in.; pp. 384; 225 line cuts in the text. Address the author, Mashkof per D.I.A.K.F., Moscow Center, Russia. (U.S.S.R.)

1929 SUPPLEMENT TO BOOK OF A.S.T.M. STANDARDS. Philadelphia: American Society for Testing Materials. Paper: 6x9 in.; pp. 293: halftones and line cuts. $1.50.

SURFACE WATER SUPPLY OF NEW JERSEY to September 30, 1928—By O. W. Hartwell, in co-operation with the United States Geological Survey. N. C. Grover, Chief Hydraulic Engineer. Bulletin 33. Trenton: Board of Conservation and Development. Paper: 6x9 in.; pp. 301; illustrations and tables.

Brings together heretofore scattered federal, state and local New Jersey stream flow records, some of which are continuous from 1891.

TABLES AND DIAGRAMS of the Thermal Properties of Saturated and Superheated Steam—By Lionel S. Marks, M.M.E., Professor of Mechanical Engineering, Harvard University and Massachusetts Institute of Technology, and Harvey N. Davis, Ph.D., Professor of Mechanical Engineering, Harvard University. Fifteenth impression with additions. New York and London: Longmans Green & Co. Cloth: 6x9 in.; pp. 110; line cuts. $2.

First printed in 1909, these useful tables are now in their fifteenth printing. Corrections were made in the printings of 1912, 1914 and 1916, and "additions" are indicated on the title page of the present issue, but apparently the book today is very much as it was when first published, as perhaps might be expected in tables of this kind.

TESTS OF STRENGTH OF ROOF SUPPORTS Used in Anthracite Mines of Pennsylvania—Report of the United States Bureau of Mines to the Pennsylvania State Anthracite Mine Cave Commission and Review of the Compressive Strength of Anthracite, Bituminous Coals and Mine Supports. Paper: 6x9 in.; pp. 44; 30 halftones. 15c. from Superintendent of Documents, Washington, D. C.

Letters to the Editor

European Lumbering Methods Are Very Unlike Ours

Sir—A bulletin on conservation of timber resources in this country that came to the writer's attention recently cites the city of Zurich, Switzerland, as an example of what can be done in reforestation. Zurich, the bulletin says, has owned a forest for more than a thousand years and for 600 years has cut a timber crop each year, leaving the forest today in better condition than ever before.

This record takes on a somewhat different aspect when viewed in the light of information about French lumbering methods brought back by our boys who were overseas during the war. For example, a man who served in the Forestry Corps of the U. S. Army employed in getting out timber and lumber in France makes, in substance, the following report:

An American sawmill had been set up in a French forest. The natives day after day gathered around it in awestruck silence. They seemed to think some sort of destructive magic was being used.

While on leave the witness saw a crew of natives carrying on lumbering operations after their customary fashion. They got down one tree, hauled it on wagons, full length, to a saw run by water power. That was one day's work. The next day, from daylight to dark, was consumed in getting *one* cut off the tree. As the leave of absence then expired, the witness could stay no longer, but he supposes they are still sawing on the same tree. He expresses no surprise that European forests have time to regrow.

The rip-slashing methods of logging in vogue in America —which are the only possible methods under present and prospective competitive conditions—are such as to make our logging practices so different from those in vogue in Europe that comparisons should be made only when all the facts are fully known. A. LUMBERMAN.

Portland, Ore.,
Sept. 1, 1929.

Grassed Shoulders Resist Erosion

Sir—In elaboration of the brief statement made in the Oct. 10 issue of the superior resistance offered by grassed road shoulders to erosion by the recent torrential rains in North Carolina the following explanation may be of interest.

When in 1926 I was placed in charge of maintenance as assistant state highway engineer I was convinced that it would be a decided advantage to secure a good stand of grass on all earth shoulders adjacent to paved highways. I was of the opinion that this was the only practicable way to make a further reduction in annual maintenance costs per mile. Maintenance equipment has been pretty well standardized, and therefore the logical way further to reduce main

tenance costs will be to lengthen the maintenance sections without increasing the equipment or labor necessary properly to maintain the road. With this idea in mind I have made a decided effort to encourage the district engineers in the sodding or planting of grass on all of their earth shoulders, and during the past three years the percentage of shoulders grassed has increased from approximately 30 to 50 per cent. The average length of maintenance sections on paved roads in 1926 was about 20 miles, and the average length of these sections today has been increased to approximately 25 miles. I feel sure that this has been due primarily to securing a good stand of grass on the shoulders.

The work has been carried on under the supervision of the individual district engineer in the nine districts, and the results so far obtained by them have been extremely satisfactory. No definite state-wide plan was adopted, but each district engineer has been working out the problem in his district in accordance with his best ideas.

Under heavy torrential rains exposed earth shoulders will wash and slough off, the amount of this sloughing or washing being dependent upon the grade of the road and the character of the soil. Where grass has been secured both on the shoulders and on the side slopes, a marked difference can be noted in the amount of washing, and sloughing is negligible. Whenever the rains are heavy enough to cause the creeks and rivers to rise out of their banks, the approach fills naturally create an obstacle to a free runoff of the water. This results in the water rising on the upstream side of the fills anywhere from 1 to 4 ft. higher head than the water on the downstream side of the fill. This difference in elevation is dependent upon the size of the stream. Therefore, if the flood reaches such proportions as to carry the water over the highway, it will be seen that on the downstream side of the road considerable current will be created over the highway. Under such conditions grassed shoulders in this state have practically eliminated any wash, whereas the exposed earth shoulders in such instances have completely sloughed off, washed away and in a number of instances undermined the paved slab to such an extent as to cause it to fail completely, or at least for one-half of the width of the road.

Raleigh, N. C., Oct. 11, 1929. JOHN D. WALDROP, State Highway Engineer.

Dictatorial Policy Throttles Discussion

Sir—An editorial in the Sept. 26 issue of *Engineering News-Record* entitled "Equipment Thinking Lacking" comments on the fact that "when it comes to secure the cooperation of the membership at large [of the American Society of Civil Engineers] in discussing and criticising the reports by letter, practically nothing is forthcoming."

Is not this difficulty very largely due to the present attitude of the publications committee of the society in insisting upon recasting not only the English but the subject matter of discussions to fit the Procrustean bed established at headquarters? In my own case and in the instances of a number of my friends and acquaintances, members of the society, including among them the winner of one of the important prizes of the society, efforts to insure that discussions represent the opinion of the discussers and not of some editor at headquarters resulted in either complete withdrawal or a yielding to the changes on the ground that the discusser had no more time, as the vice-president of a very large public utility stated, "to waste time squabbling" with the headquarters staff.

The society has set up some excellent requirements as to papers; it has certain others which to some seem undesirable but which have been well established by a long enforcement. As regards these no one can properly take exception to the demand that his paper meet them. But when the changes demanded differ greatly from these, it becomes a very different matter and the engineer who is at all busy, after one or two such experiences, is not likely to feel inclined to spend first the necessary time to prepare a discussion and then many times as much time, including, as I happen to know in two cases, a personal conference with a messenger from headquarters who made quite a visit, to argue on the situation.

That which is really essential in engineering papers and discussions is the experience of men who have something worth while to offer to their fellow engineers. This may not be put into classic language by them—if any editorial board can so shape it without changing its meaning so much the better—but the important thing is the technical fact, and I think it is the opinion of most working engineers that an illiterate expression of an important truth is infinitely better than a highly polished paraphrase that is incorrect.

New Haven, Conn., Sept. 28, 1929. CHARLES RUFUS HARTE, Construction Engineer, The Connecticut Company.

Heavy Rainfall and Hail in Central Massachusetts

Sir—The following information regarding the storm of Sept. 29, 1929, in central Massachusetts may be of some interest. In Springfield the recording gage indicated a precipitation of about 0.29 in. in three minutes, which is equivalent to a rate of 5.8 in. per hour for this brief period. The storm center, however, was probably some 2 miles northerly of the rain gage. The chief damage in Springfield was caused by hailstones. Mr. Lumis, the building commissioner of Springfield, in whose house many windows were broken by the hailstones, states that the ground was well covered with them and that he measured some of them with the following results.

The minimum size was spherical with ½-in. diameter. Great quantities were spherical with ¾-in. diameter. Large numbers were spherical with 1¼-in. diameter; one spherical with 1⅜-in. diameter; one eggshape, longest diameter, 1⅞ in., short diameter 1¼ in. The hailstones were frozen very hard, similar to ice frozen in refrigerating machines. Shattered glass from Mr. Lumis' windows, broken by the hailstones, was picked up about 12 ft. away. The information on Springfield conditions was furnished by Charles H. Restall, deputy clerk of the board of public works.

In Worcester the storm was intense but brief and local in extent. A non-recording rain gage at the home of Dr. Charles F. Brooks, meteorologist and climatologist of Clark University, showed a precipitation of 1.52 in. in eighteen minutes, or at the rate of 5.06 in. per hour. The time taken was between the first and last drops of rain in the storm, but the bulk of the water probably fell in half of this time, which would give an extremely high rate of precipitation. A milk bottle on the porch at Dr. Brooks' home showed a corrected precipitation of 1.57 in. during this time. Two other rain gages, some distance away from this one, reported only 0.99 and 0.66 in. during this shower.

Boston, Mass., Oct. 8, 1929. HARRISON P. EDDY, JR.

Concrete Should Not Be Poured

Sir:—For some 25 years I have belonged to a small minority of engineers who have been trying to remove the word "pour" from concrete specifications, because we know from long experience and observation that the use of enough water to permit of "pouring" produces very poor concrete for structures resisting water pressures.

Every engineer whose motto is "How well can I do my job?" instead of "How cheaply can I do it?" knows that one of the outstanding reasons why American engineers do not have as high a place in our civic life as should be the case is because our engineering ideals are on a par with the quality of the work we do.

I have just had a year-long successful battle in Russia about chuting concrete on the Dnieprostroy work, where about 1,600,000 cu.yd. of masonry is to be deposited, and not poured. You can imagine my disgust in Russia recently in having the front-page picture of the Bull Run (Portland, Ore.) dam (your Aug. 8 issue) called to my attention as an implied indorsement of "pour" methods by our foremost American engineering publication. Fortunately, the article written by Mr. Bowers, "The Effect of Percolating Water on Concrete Dams," in the same issue helped, I am sure, to rebut the picture on the first page. HUGH L. COOPER.

New York, N. Y., Oct. 1, 1929.

The picture on the Aug. 8 issue was of the Bull Run dam during construction, showing the lines of chutes used to deliver the concrete to the dam.—EDITOR.

News of the Week

New Jersey Commission Changes Plans for River Crossings

The New Jersey State Highway Commission has decided to abandon its plan to build the bridges to span the Hackensack and Passaic rivers with an underclearance of 35 ft. and will build structures 135 ft. in height. The spans will serve as a part of Route 25 connecting link of the Holland tunnel route between Newark and Jersey City.

Permits had already been obtained for the 35-ft. structures from the War Department and the Board of Conservation and Development, but the commission decided to accept the recommendation of Jacob L. Bauer, state highway engineer. New permits will be requested.

The high-level bridges will permit a more direct route between the two rivers at lower cost, the engineer told the commission.

Lower Court Is Overruled on Greater Pittsburgh Charter

By a decision of the Supreme Court of Pennsylvania the question of the resubmission of the Greater Pittsburgh charter is left in the same status as it was when defeated at the special election last June. The decision reverses that of the lower court stating that the county commissioners have no duty or authority to resubmit the charter and leaves the whole matter undecided.

The court says lack of actual controversy leaves it without jurisdiction.

To Celebrate Completion of Ohio River Improvements

On Oct. 17 and 18 Pittsburgh, Pa., will celebrate the opening of all-year-round navigation on the Ohio River and the completion of the river improvements by the U. S. government started 50 years ago. Similar celebrations will be held at points on the river as far south as Cairo, Ill., as the event will mark the completion of the 9-ft. stage between that city and Pittsburgh.

Bids Opened for Raising Height of Aswan Dam

The Norton-Griffiths Company, English contractors, submitted the lowest bid, $9,800,000, for increasing the height of Aswan dam. Eleven bids were received for the work. The next lowest bid was that of Topham, Jones & Railton, Ltd., $12,060,000. The smallness of the low bid was a surprise to the Egyptian government officials.

Saluda Dam Intakes Given Severe Test by Heavy Flood Discharge

Peak of 68,000 Sec-Ft. Discharged During Recent Flood — Reservoir Within 18 Ft. of Present Crest

DISCHARGING a maximum of 68,000 sec-ft. during the recent floods, the outlet works of the Saluda River hydraulic-fill earth dam under construction near Columbia, S. C., received a far more severe test than will ever occur during normal operating conditions. The only damage to the conduits was the blowing off of a section of retaining wall at the lower end of the arch conduit when its inlet gates were closed after the flood had passed. Corrected calculations indicate that a maximum inflow of 120,000 sec.-ft. into the reservoir was reached during the height of the flood. These figures correct a statement made in these pages last week relative to the inflow and discharge. The discharge figures were obtained by a current meter located about half a mile below the dam.

At the time of the flood the upstream dike of the dam was at El. 325 (Fig. 2). From El. 300 to El. 325 the dike consisted of a new trestle fill which had been spread to a width of 40 ft. on top and had become fairly well compacted. Although the reservoir level rose to El. 307.5, or to within 18 ft. of the top of the dam, no apprehension was felt for the safety of the structures. For a part of its length it had been sloped on the upstream side and some of the riprap placed.

Ultimately the dam will be 213 ft. high, with a crest length of nearly 8,000 ft., and will contain 11,000,000 cu.yd. of fill. To date 7,900,000 cu.yd. has been placed in the dam. The lowest point of the fill is at El. 159; the crest will be at El. 372, and a maximum lake level at El. 360. At this level the lake will cover an area of 78 square miles and will contain 96 billion cubic feet of water (*Engineering News-Record*, April 25, 1929, p. 669). Four penstock pipes 16 ft. in diameter and a 48-ft. arch conduit through the dam have been diverting the streamflow. The intake to the arch is through six 10x10-ft. gates located at El. 271 in a vertical tower. The penstock intakes are at El. 165.

In accordance with predetermined plans, the penstocks and conduit were closed on Aug. 31 to permit the reservoir to start filling, with the intention of keeping the water level below El. 290. Heavy rains commenced falling throughout the entire Southeast Sept. 25, and by Monday, Sept. 30, the Saluda River was rising so rapidly that the arch conduit was opened, and the four

FIG. 1—MAP OF SALUDA DAM DRAINAGE AREA

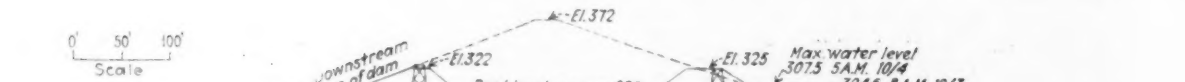


FIG 2—TYPICAL CROSS-SECTION OF SALUDA DAM AT TIME OF FLOOD

penstocks were opened the next day. Despite the opened gates the lake level continued to rise rapidly on Tuesday and Wednesday, and reached a maximum level of El. 307.5 at 5 a.m. Oct. 4. This level was maintained for eight hours before the lake slowly commenced dropping. Rain stopped falling Tuesday night, Oct. 1.

At the maximum level (El. 307.5) the lake contained 25 billion cubic feet of water. There was storage capacity for another 15 billion cubic feet before the waters would have overtopped the dike at El. 325. The lake was at El. 250 on Sept. 26 and contained 3.6 billion cubic feet of water. Calculations show that 21.4 billion cubic feet was impounded during the flood and 26.1 billion cubic feet was spilled, giving a total flood of 47.8 billion cubic feet, the heaviest ever recorded in the Saluda River valley. The gates on the arch conduit were closed on Oct. 6, and one penstock was closed on Oct. 10, another on Oct. 11 and the two remaining penstocks were closed on Oct. 11 and 12, when the lake level had fallen to El. 270.

RAINFALL IN SALUDA RIVER DRAINAGE AREA ABOVE SALUDA DAM

Sept.	Dam	Little Mtn.	Saluda	Chappels	Newberry	Laurens	Greenwood	Pelzer	Greenville
25	...	...	...	0.02	...	...	...	2.92	...
26	...	0.70	2.37	2.40	...	8.15	...	3.32	3.20
27	...	...	0.75	3.50	...	...	...	0.06	2.00
28	0.66	0.60	0.51	1.90	...	...	10.95	2.20	2.18
29	...	...	...	...	...	...	...	...	...
30	1.07	2.00	1.06	0.95	1.34	1.00	2.15	0.34	0.86
Oct.									
1	6.00	7.30	9.46	7.21	8.70	6.70	6.72	2.45	3.76
2	0.10	0.18	0.18	...	0.21	0.23	0.15	...	0.14
	7.83	10.78	14.33	15.98	10.25	16.08	19.97	11.29	12.14

The synchronizing of heavy rains at the dam with waters coming from earlier rains up the valley was responsible for the magnitude of the flood. This is shown by the accompanying table and the map in Fig. 1. All of the rainfall recorded in the last three days in the table fell in 35 hours.

Damage to the dam and structures was slight considering the magnitude of the flood and the stage of construction operations. When the gates were closed on Aug. 31, work was commenced on the power house, at the downstream toe, in the dry, one unit having been started within a cofferdam before closing the gates. Opening the gates threw the full force of the discharge against the power house foundations and lower walls. One concrete wall that had been poured two days before opening the gates was lost. The remaining part of the structure apparently withstood the flood without damage. A section of railroad track and trestle below the power house was washed away.

The four penstock pipes and the arch conduit pass through a heavy concrete retaining wall at the downstream toe of the dam. When the last two of the six gates at the conduit inlet were closed, after the lake began to drop, a violent surging occurred in the conduit. This action blew out a 38-ft. length of the retaining wall immediately over the conduit, and disturbed the adjoining sections, moving one out of line.

As the waters were withdrawn from the face of the dam several long slumps occurred on the upstream slope. One of these, about 450 ft. long, occurred in a riprapped area, and will necessitate replacing the stone. The most serious slump was about 500 ft. long, dropping about 10 ft. vertically.

The development is being built by W. S. Barstow & Company for the Lexington Water Power Company. The Arundel Corporation, as subcontractor, built the outlet works and is building the earth dam. Murray & Flood are engineers, and Albert S. Crane is consulting engineer on the project.

Three Members of Am.Soc.C.E. Elected Honorary Members

Three members of the American Society of Civil Engineers were raised to the grade of honorary membership by action of the board of direction just previous to the fall meeting at Boston last week. The members so honored are Edwin A. Fisher, of Rochester, N. Y.; Gustav Lindenthal, of New York, and George F. Swain of Cambridge, Mass. Mr. Swain had accepted honorary membership before the Boston meeting concluded and his election to that grade was included in the report published last week. The two others have now accepted.

The formal conferring of honorary membership will take place at the annual meeting of the society, which will be held in New York City next January.

Savannah River Floods Part of Augusta, Ga.

By Ralph S. Howard

U. S. Engineer Office, Savannah, Ga.

The people of Savannah, Ga., awoke the morning of Sept. 28 to find that a total of 8.84 in. of rain had fallen in the past 34 hours over the 7,294 square mile basin of the Savannah River and that a river stage of between 46 and 47 ft. was predicted by the Weather Bureau. The business district and a large part of the residential section of the city are built on the bank of the Savannah River from 30 to 40 ft. above the zero of the Weather Bureau gage. The city is protected by an earth levee constructed in 1912 extending along the river for a total distance of 12 miles. This levee broke in two places below the city during the floods which followed this heavy rainfall, with the result that backwater from these breaks inundated farm lands and a portion of Augusta itself.

On the opposite bank of the river, in South Carolina, some houses and wooden structures floated away, and many buildings were covered. A portion of the concrete trestle of the Sand Bar Ferry bridge, 4 miles below the city, was carried away.

The river receded slowly to about 28 ft. on the gage three days later, and then additional rainfall of 7.84 in. fell over the basin in a period of 30 hours. The river took a quick rise to 45.2 ft., and backwater again began coming into the city, exceeding slightly the height reached during the first rise. The Sand Bar Ferry trestle was further damaged, and two spans of both the Southern Railway and the Center Street highway bridges in Augusta were washed away. The Augusta Canal, running parallel to the levee, which is used to furnish water power to mills along the river at Augusta, was washed out at three places, and two highway approach fills on the Carolina side of the river were washed out.

Protection work on the levee was started after the first rise, after certain sections had started sloughing on the river side and numerous sand boils had shown up back of the levee. A patrol was established, and the work of revetting the caving banks with sandbags was carried on from Tuesday, Oct. 1, until the flood subsided below the 35-ft. level at the end of the week. This work was directed by the writer.

Centralia, Wash., Votes to Complete Hydro-Electric Project

By 1,600 to 232 the citizens of Centralia, Wash., voted to continue construction of the $1,000,000 hydro-electric project on the Nisqually River. This was the second time the matter had been submitted to the voters, as the Supreme Court declared the first election invalid because sufficient notice had not been given. (See *Engineering News-Record*, Sept. 19, 1929, p. 474.) More than half the 9-mile diversion canal and two-thirds of the diversion dam and intake works have been built. The city council will now take steps to issue $650,000 bonds to complete the plant, which will produce 11,000 hp.

American Association of Engineers Elects Officers

The board of directors of the American Association of Engineers held its fall meeting in Chicago on Oct. 11-12. This was the board's first meeting under the revised constitution and was for the purpose of electing officers of the association. The election resulted in the choice of the following: president, H. A. Wagner, Mayer, Ariz., and Chicago, Ill.; vice-president, James H. Griffin, New York City; treasurer, H. W. Clausen, Chicago; secretary, M. E. McIver, Chicago.

Officers Nominated for American Concrete Institute

The nominating committee of the American Concrete Institute reports the following nominations for offices to be filled at the next convention: president, Duff A. Abrams; vice-president, Arthur R. Lord; treasurer, Harvey Whipple.

South Carolina Road Bond Issue Approved by Court Decision

Funds Assure Completion of State's Primary Highway System—Will Repay Counties

MONEY to complete the state highway system of South Carolina is assured by the approval on Oct. 12 of the state's proposed $65,000,000 road bond issue. The decision was made by a court composed of the all circuit court judges of the state convened as a court "en banc." This concludes possible litigation in the state courts.

A legal decision on the bond issue was necessary because a provision of the Constitution prohibits any increase in the state's bonded indebtedness without submitting the question to a statewide vote. This was not done. The courts interpreted the Constitution as applying to bonds issued against direct taxation only. The highway bonds are to be paid by special taxation, which means 5c. of the present 6c. gasoline tax and the auto license tax. Of the gas tax 1c. will go direct to the counties as a county tax.

A statewide highway program started several years ago provides for the surfacing of 5,800 miles of road, 3,200 miles to be hard surfaced and 2,600 miles to be otherwise surfaced. Of the total hard surfaced mileage, 1,200 miles have been completed or are under construction. Over 2,000 miles of the other classification have been completed. About 1,000 miles of earth roads will be surface treated. From 50 to 60 new bridges are also on the program.

Since the start the program has been carried on by funds advanced by the counties. This plan was given the sanction of the courts in 1926. Since 1926 the counties have advanced $45,000,000, which has been reduced to $41,000,000 by the state. The new bond issue will be used to pay off this indebtedness to the counties, as well as to finish the program. The complete road program will call for expenditure of $70,000,000. The $5,000,000 not provided for by the bond issue will be furnished by the current revenues of the state.

Judge Rules for Landowners in Flood-Control Project

Judge B. C. Dawkins, of the U. S. court of the Western District of Louisiana, has ruled that the government, before condemning and taking possession of land to be used for the proposed Monroe Circle levee as embodied in the Jadwin plan for Mississippi flood control, must make a deposit sufficient to cover maximum damages to the owners. This ruling is in accord with that of Judge Faris, who made a similar decree in favor of the landowners in New Madrid and Mississippi counties, Missouri, as stated in *Engineering News-Record*, Sept. 19, 1929, p. 474.

Road Builders' Association Announces Official Ticket

The American Road Builders' Association has received the following official nominations for officers for 1930-31 from its nominating committee: president, W. A. Van Duzer, Harrisburg, Pa.; vice-presidents, J. R. Draney, Louisville, Ky.; Henry G. Shirley, Richmond, Va.; S. F. Beatty, Chicago, Ill.; Samuel Hill, Seattle, Wash.; treasurer, James H. MacDonald, New Haven, Conn.

ARMY ENGINEERS WHO WILL MAKE NICARAGUAN CANAL SURVEYS

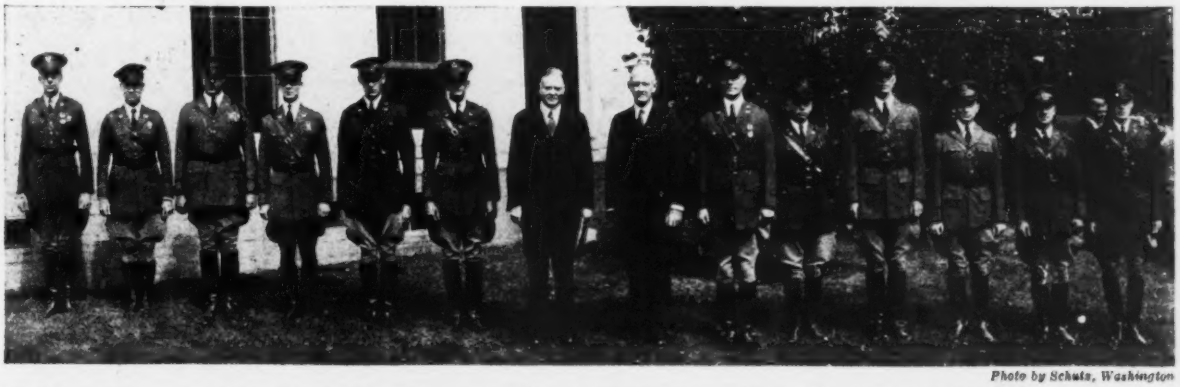


Photo by Schutz, Washington

President Hoover on Oct. 4 received the officers of the Engineer Battalion recently organized to survey the Nicaraguan Canal route. The photograph, taken on the White House grounds, shows the following: Capt. B. M. Harloe; Lieuts. K. ap Rice, L. R. Groves, Jr., D. A. Newcomber, S. J. Horn and G. E. Linkswiler; President Hoover; Major-Gen. Lytle Brown, Chief of Engineers; Major C. P. Gross, commanding the battalion; Lieuts. W. O. Van Giesen, A. L. Lane, C. D. Curran, W. E. Potter and K. D. Nichols.

The battalion, which will be commanded by Major C. P. Gross, has been formed of the Headquarters and Service Platoon and Company A, 29th Engineers, Fort Humphreys, Va.; Company A, First Engineers, Fort du Pont, Del.; and Company F, 11th Engineers, from Panama. The latter company is already in Nicaragua as an advance detachment. The survey is to be carried out under the direction of the Chief of Engineers, whose personal representative in Nicaragua is Major Daniel I. Sultan. Headquarters will be established on Lake Nicaragua.

Pennsylvania Railroad Awards Contract for Electrification

The contract for the electrification of the main line of the Pennsylvania Railroad from Manhattan Transfer to New Brunswick, N. J., has been awarded to Gibbs & Hill, of New York, for about $6,000,000, it is announced. This contract is part of the project for electrification of the road from New York to Wilmington and eventually to Washington. Tracks between West Philadelphia and Trenton already are being electrified.

The entire task is to cost $100,000,000 and to take about seven or eight years. Electrification between Philadelphia and Wilmington was completed a year ago.

Engineers Discuss Practice in Railway Track Work

Economic aspects of practical railway work were discussed at the recent annual meeting in Chicago of the Roadmasters and Maintenance of Way Association. Detection of transverse fissures in rails by the newly developed electrical apparatus was described by C. W. Gennet, Jr., of the Sperry Rail Service Company. It was pointed out by W. C. Barnes, of the rails committee of the American Railway Engineering Association, that the detector car has been run over 2,200 miles of track and has averaged a fissure for every 10 miles. The New York Central is considering a much larger and more powerful detector, according to C. B. Bronson, assistant inspecting engineer, who also referred to the desirability of extensive research in rail manufacture in order to prevent the formation of rail defects. Methods of good practice in laying rails were reviewed in a committee report presented by C. W. Baldridge (Santa Fe Railway). Another report dealt with the control of the renewals, while the practice of the Santa Fe Railway in the production and care of ties was described by R. S. Belcher, manager of treating plants.

That further increase in locomotive weights and wheel loads is improbable was suggested by R. H. Ford, assistant chief engineer of the Rock Island Lines, so that in future there may be greater stabilization of track construction and maintenance. The stabilization of track forces was the subject of a paper by H. S. Clarke, engineer of maintenance-of-way of the Delaware & Hudson Railroad, who described methods employed on that road. By paying section men an hourly rate, which is increased every year, they are encouraged to remain permanently. Foremen and assistant foremen have monthly pay. Along the same lines was a paper on getting the most service out of labor-saving equipment, by M. M. Backus, assistant chief engineer of maintenance-of-way of the Illinois Central Railroad. Machines should be kept in use as much as possible, but they need to be handled efficiently and there should be a system to insure supervision of the work as well as regular inspection and repair of the machines.

Comparisons of cost of various methods of killing weeds, by hand cutting, burning, steaming and chemical solutions, were given in a report presented by A. Chinn, district engineer of maintenance-of-way, Chicago, Burlington & Quincy Railroad. Surprise checking of the work of section forces was advocated in a report on "Correction of Unsafe Methods in Track Work," by G. H. Warfel, assistant general manager, Union Pacific Railway. A report dealing with the selection and training of section foremen was presented by G. T. Donahue, assistant division engineer of the New York Central Railroad.

Officers for 1929-30 include: president, E. E. Crowley, general roadmaster, Delaware & Hudson Railroad; vice-presidents, Elmer T. Howson, Western editor of *Railway Age*, and C. W. Baldridge, assistant engineer, Santa Fe Railway; secretary, T. F. Donahue, general supervisor, Baltimore & Ohio Railroad, Pittsburgh, Pa. The next meeting will be held at Chicago in September, 1930. The association has now 874 members.

Traffic Committee Organizes Work at First Meeting

The first meeting of the committee for the relief of traffic congestion appointed by Secretary of Commerce Lamont to continue the work of the National Conference on Street and Highway Safety was held in Washington, D. C., Oct. 10. In the absence of Edward J. Mehren, vice-president of the McGraw-Hill Publishing Company and chairman of the committee, William Wilgus presided as acting chairman. Norman Damon, of the National Automobile Chamber of Commerce, Washington, D. C., is secretary. The members present included representatives of all the interests concerned in improving traffic conditions both urban and rural: traffic engineers, automobile clubs, firefighters, taxicab operators, trucking companies, police departments, merchants, motor manufacturers, governmental bureaus, street railways and others.

The meeting was devoted to a preliminary exchange of views as to the various aspects of the highway traffic problem, to the formulation of a plan of procedure and to the organization of suitable sub-committees. The consensus of those present was that the immediate and urgent need is to make more intensive use of present facilities, while planning and building new facilities for permanent relief and future needs. More effective control of parking, better timing of signals, more general "laning" of traffic, diversion of through traffic from congested centers and, generally, a closer supervision and enforcement of existing regulations were offered as helping toward the end. Special emphasis was laid upon excessive parking, so that, as expressed by one member, "the highways may be rededicated to the purpose for which they were provided—the movement of traffic—rather than to the storage of vehicles."

A plea for more complete studies to determine and analyze the necessary data upon which to base conclusions was voiced by the traffic engineers present, while all agreed that it is essential to realize a greater co-ordination of the many officials and departments now having to do with traffic control. General education of the public and business interests of every community were held to be vital if the work of the committee is to be fruitful.

The committee adopted a plan of procedure embracing three major sections: (1) study of location, causes and effects of congestion; (2) remedies and their appropriate application; (3) methods of local procedure to apply the findings of the committee. Three sub-committees were appointed to carry on along these lines; their chairmen are Harold S. Buttenheim, editor of *The American City*; J. Gordon McKay, director of the Cleveland Highway Research Bureau; and Harold M. Gould, consulting traffic engineer to the Police Department of Detroit. It is expected that their work will be put in hand at once and that they will report to the general committee on their respective subjects by January.

New Mexico Experiences Worst Flood in Its History

In August the Rio Grande rose over its banks to inundate 30,000 acres of land. (See *Engineering News-Record*, Aug. 22, 1929, p. 310.) Reconstruction and rehabilitation work was scarcely well under way before another and greater flood came on Sept. 22-26. The second flood, authentic details of which are just becoming known, has been called the greatest experienced in the 300 years of written history in New Mexico. Fifty-two miles of valley, averaging a mile in width, was completely inundated and for most of this distance was badly scoured. No accurate measurements were taken, but hydraulic engineers estimate the flow at 62,000 sec.-ft. The Santa Fe Railroad was the heaviest loser, with an estimated figure of more than $1,500,000. Another million would hardly cover the loss of individuals and towns in the valley.

As the waters subsided a deposit of silt from 4 to 10 ft. deep was left over all the land. The town of San Marcial, where railroad shops and offices were located, is now under 7 ft. of silt and will be abandoned by both railroad and townsfolk.

The Rio Grande has changed its course in numerous places throughout the flood area, going as far as a mile west of its old channel. The Santa Fe Railroad has put on large crews of men and is building a 2,000-ft. creosoted timber and pile bridge at San Acacia, the farthest north break of the river, a smaller bridge about a mile south of

there, where the river swings back east on its new course, and several minor structures are scheduled down the valley, specifications for which have not yet been made public.

The state's highway system through the flood area suffered a hard blow, but not comparable to that by the railroad. Three state bridges and one county bridge were taken out. A mile and a half of federal-aid road is now in the heart of the new channel of the river. A mile of road near the town of San Antonio was under water but was not permanently damaged, while more than a mile of road in and near the town of San Marcial is permanently lost under silt.

The work the railroad is doing is not permanent necessarily, it is announced, as it is possible that an entirely new location will be made through the valley, while no definite rebuilding or relocation plans have been announced by the state highway department. The plans of the $13,000,000 Middle Rio Grande Conservancy District, a proposed reclamation and flood-control project, were taken into consideration on rebuilding plans after the first flood, but as this project is still in litigation as to legality of bonds, it is being ignored in plans formed now by affected corporations and districts, as the danger of other floods is too pressing to wait on the proposed district.

High Wind Breaks Hangers in New Tied-Arch Steel Bridge

Temporary repairs have been made to the new Tacony-Palmyra bridge at Philadelphia, whose main span was damaged in the high wind which swept the Atlantic coast on Oct. 2, and traffic is now passing over it after having been detoured for two days. Final repair, consisting of replacement of the damaged members and strengthening of some parts, is going forward under direction of the steel contractor, whose forces were still on the bridge, although it had been opened to traffic Aug. 14.

Damage to the structure, which is a 550-ft. span-tied bowstring arch, consisted principally in the severing of two hangers located at the center of the span and having a length of approximately 99 ft. Failure occurred near the top of the 18-in. rolled I-section hangers through the bottom rivets that connect them to the bottom chord gussets of the arch-rib truss. The broken hangers were on the windward side of the bridge. It is reported that excessive vibration was noted in the hangers at the time of the storm in which the wind velocity reached an estimated maximum of 75 miles per hour. The hangers were spliced at their midpoints, but all damage was confined to the rigid connections at the top.

The Tacony-Palmyra bridge connects an industrial section of Philadelphia with highways in New Jersey leading to Atlantic coast points, and affords a route by which through traffic can bypass the business section of Philadelphia. It is a privately owned toll project designed by Modjeski, Masters & Chase, consulting engineers, Philadelphia, and erected by the American Bridge Company. A news article describing and illustrating the structure was published in *Engineering News-Record*, Aug. 22, 1929, p. 310.

The Business Outlook

There is so far no evidence of any general or unnatural slump in business. What is happening is apparently only a gradual readjustment of the automobile - building - steel group of industries back to a more normal level of activity following a long period of unseasonable or excessive expansion. The slump in construction also is mainly in residential building; the heavier types of construction have run consistently ahead in 1928. The credit outlook will remain uncertain and unfavorable until further decline in price levels here and abroad, with threat of business recession, brings about a change in banking policies. This will probably not be possible until the stock market readjustment now going on here is completed. The weakening in prices continues; the general level is now almost 5 per cent below last year. General trade indications are good.

—The Business Week, Oct. 12

San Francisco Bridge Commission Begins Investigation

Governor Young, of California, has named the following members of the San Francisco-Alameda County Bay Bridge Commission, which has been formed to study the problems and reach agreements incident to the construction of a bridge across San Francisco Bay: George T. Cameron, publisher of the San Francisco *Chronicle*; Arthur H. Breed, Oakland, state senator from Alameda County, who was the original sponsor of the Senate bill authorizing the State Department of Public Works to lay out and construct a highway crossing from San Francisco to Alameda County; Charles D. Marx, professor emeritus of civil engineering at Stanford University; Charles H. Purcell, state highway engineer, who formerly was connected with the United States Bureau of Public Roads.

The Governor's appointments complete the personnel of the commission, of which President Hoover already had appointed the following members: Rear Admiral W. H. Standley, Rear Admiral L. C. Gregory, Col. G. B. Pillsbury, Lieut.-Col. E. L. Daley and Mark L. Requa.

Following a preliminary organization meeting in Sacramento on Oct. 7, the commission selected spent three days in trips of inspection to the various proposed bridge sites and other points of interest in the vicinity. At the first meeting Mark L. Requa, civilian appointee of the President, was elected chairman; G. T. Cameron, vice-chairman, and C. H. Purcell, secretary.

Resolutions were adopted at the first meeting, stating that the problem of the commission is to endeavor to solve the state and interurban traffic problems that exist between San Francisco and the east side of San Francisco Bay in such a manner that the solution will not conflict with national defense requirements and the interests of navigation. A further resolution requested that the California Department of Public Works be asked to make a study of the economic and traffic questions involved so that data will be available for subsequent meetings.

As a result of these preliminary investigations it is reported that the commission will proceed to have data accumulated to be used as a basis for a report to President Hoover. Four major lines of study will include: (1) borings and a complete study of bay floor conditions to permit a preliminary determination of pier construction problems; (2) survey of bay navigation, including a study of ferry traffic; (3) study of all present and proposed air terminals and all aviation manufacturing facilities in the district; (4) review of the major highways serving the region, including present and future traffic needs.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Hoover to Push Government Mapping — New Problems in Rail and Water Transport

COMPLETION of the map of the United States within eighteen years is the aim of President Hoover, according to a personal announcement made Oct. 8. The President indicated that the budget to be presented to Congress Dec. 2 will contain an item of $1,000,000 for that purpose. At the present time expenditures for topographic mapping are at the rate of $625,000 annually, which means that nearly 80 years would be required to complete the map.

Apparently it is the intention of the President to submit estimates for larger amounts in subsequent years. Practically all of the increase allowed for the first year's work must be expended for the advancement of horizontal and vertical control, which is inadequate for even the present program. Work is being held up at several points until the control can be run.

In explaining the need for detailed maps President Hoover pointed out that 20,000 cattle had been lost during the 1927 flood in the Mississippi Valley because of the fact that no one knew

the exact elevation of the ridges where they would have been above the advancing waters.

Barge Lines and Railways

The government's future policy toward promoting co-ordination among public carriers on the inland waterways and connecting railway lines may be determined by the application of the Mississippi Valley Barge Line Company for a certificate of public convenience and necessity that is pending before the Interstate Commerce Commission. This is the opinion of shipping men who are in touch with the situation.

The company intends to start weekly common carrier service between Cincinnati and New Orleans, beginning about Feb. 1. Under the Denison amendment to the waterway act, the Interstate Commerce Commission is directed to institute proceedings with the railroads requiring them to enter through routing arrangements with common carriers on the waterways. Before the commission can start this procedure, however, the waterway carrier desiring through routing with the railroads must first obtain a certificate of public convenience and necessity. The issue involved in the present case is whether or not the commission has any discretion in granting such a certificate. The wording of the Denison amendment is somewhat obscure on this point. As a result, some shipping men are of the opinion that the commission can decline to issue the certificate if it feels justified in doing so.

While the certificate of public convenience and necessity does not have to be obtained to enable a carrier to engage in operating boats on the inland waterways, it is essential as the first step toward securing joint rates with the railroads. The question of the commission's power in respect to the granting of these certificates was not raised in the case of the Federal Barge Line, as Congress itself declared that the operation of this line was in the public interest.

Store-Door Delivery

An attempt to force the Interstate Commerce Commission's hand with respect to regulation of motor truck transportation is seen in the tariffs filed by the Boston & Maine Transportation Company to inaugurate store-door truck pickup and delivery service on freight hauled by the Boston & Maine Railroad between certain cities in New England. Similar tariffs previously filed by the truck company, which is a subsidiary of the railroad company, were rejected by the commission's tariff section on the ground that it is not a common carrier subject to the interstate commerce act and that the commission does not have jurisdiction over truck transportation.

The new tariffs have been referred to the commission by the tariff section with a recommendation that they should also be rejected. A contract between the railroad and the truck company attached to the tariff reveals that the latter would receive special rates for the rail haul not shown in any tariffs the railroad now has on file with the commission. The belief is expressed at the commission's offices that hauling freight under these rates would be illegal, as they are not available to any shipper other than the truck company.

If the tariffs had been filed by the railroad, there would be no question concerning their legality, as railroads have the right to establish and maintain store-door delivery service at terminals. It is surmised that the railroad company did not follow this course because establishment of such service at a few points would have resulted in a demand for its establishment at other points on its lines. The probable result would have been that other cities would file protests charging discrimination.

Navy Planning New Landing Field

In keeping with its policy of developing landing fields for land and sea planes at all of the naval stations, the Navy Department recently authorized the construction of an airport at the Algiers, La., station, directly across the Mississippi from New Orleans. At the outset a four-directional runway will be constructed and inclined ramps will be provided for seaplanes. Funds for the execution of the work will be available well before the expiration of the present fiscal year, it is stated. Although it is not the navy's policy to encourage the commercial use of its airports, it is stated that the projected Algiers field will be available at all times as an emergency landing field for all land and sea planes. The Algiers field will also afford an excellent base for relief flights by naval aircraft in the event of flood heights on the lower Mississippi, it is pointed out.

Society Calendar

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington; annual meeting, San Antonio, Tex., Nov. 12-15.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; annual convention, Biloxi, Miss., Nov. 13-16.

ASPHALT PAVING CONFERENCE, New York City; annual meeting, West Baden, Ind., Oct. 28-Nov. 1.

INTERNATIONAL CITY MANAGERS ASSOCIATION, Chicago; annual convention, Fort Worth, Tex., Nov. 20-23.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, Washington; annual meeting, Chicago, Ill., Dec. 4-6.

SOUTHWEST WATER WORKS ASSOCIATION, Fort Worth, Tex.; annual convention, Tulsa, Okla., Oct. 28-30.

CITY OFFICIALS DIVISION, American Road Builders Association, Washington; airport meeting, Washington, Oct. 24-25.

IOWA SEWAGE TREATMENT CONFERENCE; annual meeting, Ames, Iowa, Oct. 22-24.

MISSOURI WATER AND SEWERAGE CONFERENCE; annual meeting, Chillicothe, Mo., Oct. 21-23.

NEW YORK STATE SEWAGE WORKS ASSOCIATION, Albany; fall meeting, Schenectady, N. Y., Oct. 19.

OHIO CONFERENCE ON SEWAGE TREATMENT; annual meeting, Canton, Ohio, Oct. 22-23.

OHIO WATER PURIFICATION CONFERENCE; annual meeting, Columbus, Ohio, Oct. 24-25.

Personal Notes

C. O. SUTHERLAND, formerly with the New York Air Terminals, Inc., as construction engineer on airport work, is now with Cuzzi Bros., Inc., of Mount Vernon, N. Y., in charge of estimating.

M. C. POULSEN, formerly with the department of public works of Fresno, Calif., has been appointed chief engineer of the Clay Products Institute of California, with headquarters in Los Angeles.

H. H. FRIENDLY has become associated as chief engineer with Maurice Blumenthal & Associates, contractors and engineers, of New York City. He will have charge of vehicular tunnels, toll bridges, and caisson, concrete and pile foundation works.

A. W. BERRESFORD, president of American Engineering Council, has been named managing director of the National Electrical Manufacturers' Association, to succeed Alfred E. Waller, resigned.

SAMUEL T. WAGNER, of Philadelphia, Pa., has been appointed by Governor Fisher a member of the state board for registration of professional engineers to fill the vacancy caused by the resignation of Dr. Drinker.

W. D. BEERS, formerly engineer in the road department and member of the water rights commission of the State of Washington, has been appointed by Governor Dern of that state a member of the Colorado River Commission, succeeding Richard R. Lyman, resigned.

GEORGE W. HAWLEY, of Berkeley, Calif., has been appointed to administer the California dam inspection act passed by the last legislature. He will be deputy in the division of water resources. For more than ten years Mr. Hawley was with the East Bay Water Company, in charge of water-supply investigation and construction. Since that time he has acted as consulting engineer for the Port Costa Water Company and the El Dorado Irrigation District.

Obituary

CLARENCE N. WILSON, who was the engineer in the construction of slackwater dams on the Ohio River above Portsmouth, Ohio, died recently. He was 70 years old.

WILLIAM HARRISON HERRON, engineer in charge of the central division of the topographical branch, U. S. Geological Survey, died in Urbana, Ill., on Oct. 9. Mr. Herron became associated with the Geological Survey in 1885, rising through various grades until in 1907 he was placed in charge of the central division, with the title of geographer. In 1916 he served as acting chief geographer.

Construction Equipment and Materials

Light-Weight Aggregate Patent Case Decided

That the Hayde and Olsen patents for the preparation of light-weight concrete aggregate by burning shale do not apply to the same process was stated by Judge Fred L. Wham of the United States District Court for the Eastern District of Illinois in a decision handed down Sept. 28 in the case of Silica Products Company vs. Haydite Company and Western Brick Company. The plaintiff charged that the two defendants, assignees of the Hayde patent, were infringing on certain claims of the Olsen patent, owned by the Silica Products Company. The court decided: (1) that the material produced under the Hayde patent and its method of production did not infringe upon the product and method outlined in the Olsen patent; (2) that Stephen J. Hayde had produced a light-weight aggregate for burning shale and clay before the date of Olsen's application for a patent.

Trade Practice Rules of Face Brick Industry Approved

Rules of business practice adopted by the face brick industry at a trade practice conference held in Washington, D. C., March 14, 1929, have received the approval of the Federal Trade Commission. Nine rules relating to unfair methods of competition were affirmatively approved. Eighteen other rules were accepted as expressions of the trade.

Concrete Pavement Yardage

There is given below a tabulation of concrete pavement yardage awarded during the month of September, 1929, and also the total number of square yards awarded for roads, streets and alleys in the United States for the year 1929 to date as of Sept. 28:

	Sq.Yd. Awarded During September, 1929	Sq.Yd. Awarded From Jan. 1, 1929, to Sept. 28, 1929
Roads	5,945,015	75,145,686
Streets	3,871,442	35,741,532
Alleys	403,632	2,805,271
Totals	10,220,089	113,692,489

Plan Lumber Consumption Survey

Intelligent control of the balance between supply and demand in the lumber industry is the object sought in a proposed lumber consumption survey to be made by the National Lumber Manufacturers Association, which has retained the firms of White & Parton, Inc., marketing counselors, and Gregg & Company, engineers, both of New York City, for this purpose. The services of the research department of the Metropolitan Life Insurance Company have been voluntarily offered and accepted as an additional aid. The ultimate object to be attained is a periodical survey of probable lumber requirements among wood-using industries and other consuming outlets influencing the demand for lumber. The first step to be undertaken is the preparation of a plan of procedure for this purpose. It is expected that a report on the first step will be ready for submission to the December meeting of the N.L.M.A. board of directors.

Manufactures Census Will Cover New Subjects

After weeks of conference and consideration of the statistical needs of American industry and business, the advisory committee on manufactures which was appointed last July to work with the Census Bureau on the preparation of the general schedule for the forthcoming census of manufactures has rendered its report. A suggested schedule to go out next January to every manufacturer in the country has been drawn up to include new data of great practical value to manufacturers, which will be requested for the first time.

Special efforts will be made by the Census Bureau to tabulate the resulting data in such a way as to point out the most significant industrial trends. Among these trends is that of migration of industry, which has involved the transfer of thousands of employees from one section of the country to another and has entirely changed the industrial occupation of a large portion of the inhabitants of these sections. In other cases there has been a distinct drift by manufacturers away from urban communities and out into the smaller towns. Again, a tendency toward concentration of certain industries has been prevalent, while other industries have tended to spread throughout the country. All of these trends have a large influence on the employment phases of industry. It is very generally known that such trends are under way, but no definite data are available. The data which will be made available to manufacturers through the coming census will picture very clearly these trends in industrial migration.

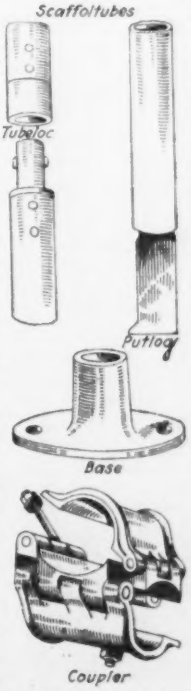
For the first time the census will make available data on the amount of idle power equipment in the manufacturing plants of the country. Estimates have been made that as much as 50 per cent of the installed power in the country is practically idle through obsolescence, overcapacity or other causes. Definite data, however, on this significant subject have never been made available from any source. Power installation is one of the best possible bases for industrial or market studies, but the inaccuracy of the available data due to the inclusion of this large amount of idle power equipment has robbed such studies of much of their potential value.

The Census Bureau is also making special efforts to get the resulting statistics on manufacturing operations back to the manufacturers as early as possible. Realizing that an early report from the manufacturers of the country is dependent very largely on the interest manifested by the manufacturers in making early returns, the advisory committee has appointed a publicity committee composed of Robert M. Davis, McGraw-Hill Publishing Company, chairman; H. P. Baker, Chamber of Commerce of the United States; and Roland P. Falkner, National Industrial Conference Board. This committee will bring the census of manufactures to the attention of the manufacturing executives in a very positive way in the next few months.

New Developments

Metal Scaffolding Adjustable to Meet Special Conditions

Flexibility in special installations is a feature of the tubular scaffolding manufactured by the Patent Scaffolding Company, New York City. This is made up of a number of standard structural elements of copper bearing galvanized steel which are assembled into position and held together by couplers. The main tubular members, known as Scaffoltubes, have an outside diameter of 2 in. and are furnished in lengths of 6, 10 and 13 ft. They are provided with Tubeloc fittings to give a positive and rigid locking connection between members. A special form of the tubing is known as a Putlog, which is designed to lock into a dry cross-joint in brick masonry and can be easily detached from the wall without marring the brickwork when the scaffolding is disassembled. Special bases are provided to distribute the load at the base of vertical columns. For right-angle connec-



SCAFFOLDING ELEMENTS

tion between horizontal and vertical members there is a standard coupler; special adjustable couplers are used for other connections in the diagonal bracing.

Tractor Attachments Provide Fixed and Swinging Booms

New boom attachments especially designed for Caterpillar tractors have been recently announced by separate manufacturers. The first of these, developed by the Allsteel Products Manufacturing Company, Inc., Wichita, Kan., is mounted on the model 30 hillside special Caterpillar, it being necessary to drill but four holes in the drawbar

TRACTOR EQUIPPED WITH FIXED BOOM

plates. It has a boom of the fixed type equipped with counterweights and also with a stiff leg for heavy lifting. The maximum height of the boom is 11 ft. The winch, driven from the power take-off of the tractor, has three speeds forward and one reverse, with a maximum pull of 12,450 lb. at a speed of 92 ft. per minute. It is stated that this outfit will raise and carry 4,000 lb. with counterweights and without the stiff leg in use, and will lift 40,000 lb. with the stiff leg in position.

A more elaborate machine for use with either the model 30 or 60 Caterpillar tractor is manufactured by the W-K-M Company, Inc., Houston, Tex. The telescopic boom, which may be raised or lowered and swung from side to side, is mounted on pinions attached to the heavy channel in the roller track assembly. A-frames are provided on each side of the tractor, connected by a cross-base. High- and low-speed winches are mounted on the left side, driven by a chain drive from the power take-off. Two auxiliary or swing winches powered through the main drive are also provided on the left side for swinging the boom. Although the normal boom length is 14 ft., it may be extended if desired to a total of 22 ft.

BACKFILLING WITH TRACTOR ATTACHMENT

The high-speed winch has a cable capacity of 250 ft. on a ½-in. line and a maximum speed of 392 ft. per minute; the low-speed winch will hold 415 ft. of ½-in. line and has a maximum speed of 247 ft. per minute. Automobile-type levers control all winches and brakes. This outfit can be used as a backfilling unit with buckets up to a maximum capacity of 1 cu.yd. Under these circumstances the high- and low-speed winches control the bucket and the boom is supported by a fixed chain.

Heavy Loads Moved at High Speed by New Trucks

Provision for high road speeds without reduction in the amount of pay load is made in the new series of superduty trucks now being produced by the Mack Trucks, Inc., New York City. These are designed to carry from 7½ to 10 tons and to develop from 15 to 35 tons drawbar capacity, using either two- or four-wheel drive and powered with four- or six-cylinder engines. Using the superduty truck as a tractor, it is possible to haul up to 35-ton trailer loads at 25 miles per hour.

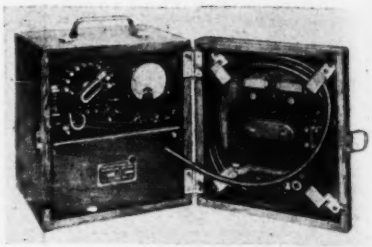
The six-wheel trucks are of special interest, being new to the Mack line. All four rear wheels are chain driven, each axle-set from a separate jackshaft having its own differential with

SIX-WHEEL HEAVY-DUTY TRUCK

hypoid gear drive. The jackshafts are separated by a power divider and compensator by which power is transmitted to each wheel in direct ratio to its tractive resistance. Brakes are fitted to all four rear wheels, these being actuated by vacuum booster power. In addition, a disk brake is mounted on the drive shaft between the two jackshafts. Each axle is suspended through a rubber block from the end of a heavy semi-elliptic spring which is anchored at the center to a horizontal bar mounted in the frame so that the load is equally distributed between the two rear axles.

Electrical Device Determines Dryness of Lumber

Rapid determination of the moisture content of lumber is made possible by a newly developed instrument known as the Tag-Heppenstall moisture meter made by the C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y. By measuring the electrical conductivity of the wood between two contact needles the moisture content is determined regardless of the species tested, with certain few exceptions. The method can be applied to most of the well-known construction woods.



DEVICE FOR MEASURING MOISTURE CONTENT OF WOOD

The meter is housed in a carrying case containing batteries, the testing handle and 10 ft. of connecting cable. There is also an instrument panel containing control switches. The whole apparatus weighs about 20 lb. To determine the moisture content of a stick it is merely necessary to drive the needle points into the timber and then to turn the selector switch until the milliammeter pointer is vertical. The switch will then indicate the percentage of moisture present in the wood. If it is desired to sort out wet stock above a certain moisture content, the selector switch is set at the upper limit and each board is tested. Any board which contains more than the limit will light a green lamp mounted in the handle of the light.

Business Notes

GUNITE CORPORATION, Rockford, Ill., has appointed Erwin J. Mohr maanger of industrial sales. Mr. Mohr has served for many years as sales manager for the Kinite Corporation, of Milwaukee, Wis.

BROWN INSTRUMENT COMPANY, Philadelphia, Pa., has completed a new building which will add 60 per cent to its capacity.

SULLIVAN MACHINERY COMPANY, Chicago, Ill., has placed its San Francisco office in charge of Perry W. Olliver. Mr. Olliver's name was given incorrectly in our issue of Sept. 26.

Costs and Contracts

E. N.-R. Index Numbers

Cost			Volume		
Oct. 1, 1929		**206.32**	**Sept., 1929**		**340**
Sept. 1, 1929		207.57	August, 1929		290
Oct. 1, 1928		207.71	September, 1928		296
Average, 1928		206.78	Average, 1928		287
Average, 1927		206.24	Average, 1927		263
1913.....		100.00	1913.....		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Oct. 17, with some comparisons, total as follows:

(In Thousands of Dollars)

	Oct. 17, 1929	Oct. 10, 1929	Oct. 18, 1928
Building:			
Industrial.....	$8,866	$2,859	$17,390
Commercial....	29,346	19,015	38,619
Streets and roads.	14,305	10 992	7,134
Other eng constr.	8,231	14,751	28,852
Total.....	$60,748	$47,617	$91,995
Total, all classes, Jan. 1 to Oct. 17:			
1929			$3,398,559
1928			2,945,270